COLLINGWOOD HARBOUR

REMEDIAL ACTION PLAN

STAGE I

ENVIRONMENTAL CONDITIONS AND PROBLEM DEFINITION

March 1989

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ENVIRONMENT ONTARIO
AND ENVIRONMENT CANADA

FOREWORD

This document provides a summary of the environmental conditions in Collingwood Harbour and identifies specific environmental problems in this Area of Concern of Georgian Bay, Lake Huron. While historically, Collingwood Harbour was an industrial harbour, current development has introduced residential and recreational interest, resulting in a multiple-use harbour with the potential for a wider array of beneficial uses. This report also represents the technical summary for use in the public involvement program initiated in the spring of 1988 and constitutes the basis of the Stage I submission of the Collingwood Harbour RAP, in accordance with the Canada-Ontario commitment to the Great Lakes Water Quality Agreement.

Table I indicates the beneficial uses that are of relevance to Collingwood Harbour based on technical information and consultation with the public and identifies those uses which are impaired. The report includes a description of the public involvement program as it has developed to date.

In order to assess remedial options for the achievement of water quality to support the desired uses goals, the following activities are scheduled for 1988/89:

° refining estimates of nutrient and contaminant loading to Collingwood Harbour for the purpose of evaluating remedial measures;

° reassessing the significance of sediment contamination to the biota through additional laboratory sediment bioassays to clarify descrepancies between field and laboratory findings;

° repeating the bacteriological sampling conducted in 1980, 1983 and 1986 to adequately assess whether current bacterial densities meet the provincial water quality objectives for swimming and bathing;

° continuing Phase II of the public involvement program. The Collingwood public advisory committee is developing a consensus on the desired uses for the harbour. The first two meetings were held November 25, 1988 and January 20, 1989.

REMEDIAL ACTION PLAN - TIMETABLE

ACTIVITY	INITIATION DATE
Phase I, Public Involvement Program	July 1987 (completed)
Identification of Desired Uses	November 1988
Identification of Remedial Options	September 1989
Selection of Preferred Remedial Options	January 1990
Draft RAP (II) for Review	March 1990
Final Collingwood RAP for Review	June 1990

TABLE I

SUMMARY OF IMPAIRMENT OF POTENTIAL BENEFICIAL USES AS OUTLINED IN ANNEX 2 OF THE GLWQA AND THEIR SIGNIFICANCE TO COLLINGWOOD HARBOUR

POTENTIAL IMPAIRED USE	SIGNIFICANCE TO COLLINGWOOD HARBOUR RAP
i) Restrictions on fish and wildlife consumption.	Human consumption advisory on yellow perch greater than 35 cm; not attributed to local sources of mercury. No other restrictions.
ii) Tainting of fish and wildlife flavour.	No reports of any tainting.
iii) Degradation of fish and wildlife populations.	Surveys indicate healthy populations.
iv) Fish tumors or other deformities.	Tumors or other deformities not reported.
v) Bird or animal deformities or reproduction problems.	Wetlands continue to support healthy communities.
vi) Degradation of benthos.	Benthic community typical of eutrophic conditions; resident fauna do not have elevated tissue concentrations of contaminants.
vii) Restrictions on dredging activities.	Concentrations of metals and PCBs in localized sediments in excess of the open water disposal guidelines.
viii) Eutrophication or undesirable algae.	Phosphorus exceeds 20 ug/l in the harbour and algae blooms have been reported. Algal growth may impair boating and reduce visibility for safe swimming.
ix) Restrictions on drinking water consumption, or taste and odour problems.	Not applicable, water intake is outside the harbour.
x) Beach closings.	Not applicable, no beaches.
xi) Degradation of aesthetics.	Current level to be maintained or improved.
xii) Added costs to agriculture or industry.	Not applicable; no industrial or agricultural withdrawals from the harbour.
Xiii) Degradation of phytoplankton and zooplankton populations.	Healthy fish community is a good indicator of viable plankton community.
xiv) Loss of fish and wildlife habitat.	No loss attributable to existing environmental conditions.

ACKNOWLEDGEMENT

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The RAP Team acknowledges the major contributions of K. Simpson, the previous Coordinator of the Collingwood Harbour RAP.

Past members of the Collingwood RAP Work Team and individuals who contributed to scientific investigations and reporting for this document are acknowledged as follows:

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The RAP Team also acknowledges the comments and suggestions received from the public advisory committee on the contents of the draft Stage I report.

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EXECUTIVE SUMMARY

Collingwood Harbour is situated in Georgian Bay on the south shore of Nottawasaga Bay. The harbour is relatively shallow with a maximum depth of 6.4 metres in the dredged portion of the 244 metre long turning basin. Collingwood Harbour encompasses roughly 0.8 km^2 in area and has an approximate volume of 28.7 x $10^{-4}km^3$. The adjacent Town of Collingwood has a permanent population of 12,000 (1985 statistics) and a sizeable population of seasonal residents. The town is serviced by a secondary sewage treatment plant (STP) with phosphorus removal. The plant discharges treated effluent to the harbour. Collingwood Harbour was first identified as a "problem area" or "area of concern" in 1977 due to nuisance algal growth (IJC 1980).

Excessive algal growth adversely constrains boating and swimming and is aesthetically unpleasing. Algal growth has been linked to phosphorus concentrations in the harbour that are in excess of 20 ug/L. Sources of phosphorus include the STP, watershed runoff, atmospheric inputs, and sediment release.

In the 1980's sediments were found to have metals and PCBs in excess of the open water disposal guidelines. The localized contamination of harbour sediments with PCBs and some metals is attributed mainly to historic use of the harbour as a centre for the repair and construction of Great Lakes vessels. These activities have ceased and do not continue to contribute to sediment contamination. Dredging carried out in 1986 by Collingwood Shipyards and Public Works Canada has removed a considerable portion of the contaminated sediments from the harbour.

A sediment bioassessment study conducted in 1986 to determine whether contaminants in sediments impaired potential beneficial uses indicated that the sediments were non-toxic to fathead minnows and mayflies. At several stations, however, bioassay organisms accumulated significant levels of lead, although this was not observed in resident biota. A study was conducted in the fall of 1988 to examine this result. In the 1986 study, several organochlorine compounds, in particular PCBs and DDE, were retained by the test species; however, the levels were low and unlikely to affect benthic organisms or to contribute to elevated levels in higher trophic levels of the food chain. Mussels suspended above the harbour sediments

did not accumulate metals or PCBs and tissue concentrations of these compounds were low in young-of-the-year spottail shiners. Together, this evidence demonstrates that, with the possible exception of lead, the harbour sediments do not impair potential beneficial uses. Advisories on human consumption of yellow perch greater than 35 cm (14 inch) due to mercury contamination are in effect. This advisory is not unlike restrictions in other areas of southern Georgian Bay and has not been attributed to local sources of mercury.

Current improvements at the Collingwood STP have reduced nutrient loads to the harbour. As of 1987, effluent phosphorus levels met the objectives specified in the Great Lakes Water Quality Agreement.

As a result of the public involvement program, a specific use goal stated that water quality should be at a level acceptable for swimming and bathing. Recent studies have shown that bacterial levels in the harbour periodically exceed the provincial objective for this use. Additional studies are being developed for 1989 to refine estimates of phosphorus, algae and bacteria dynamics in order to evaluate remedial options in light of the desired beneficial uses identified by the public advisory committee.

Phase I of the public involvement program was completed in September 1988. A public advisory committee (PAC) was formed in November 1988. The PAC has representation from municipal, industrial, recreational, environmental, business, educational, medical, and individual perspectives. Through consultation with the local public and the PAC an attempt will be made to reach consensus on the intended uses of the harbour in order to define the specific remedial measures to be instituted for achieving the level of environmental quality necessary to support those uses. A complete summary of environmental problems for Collingwood Harbour, along with the respective sources is presented in Table II.

TABLE II: SUMMARY OF ENVIRONMENTAL PROBLEMS AND SOURCES

Environmental Problem	Current Conditions	Potentially Impaired Uses	Sources of Problem	Current Information Deficiencies
1. Nuisance Algal Growth	. Harbour water exceeds PWQO of 20 ug/l of P to prevent nuisance algal growth. STP annual average of P is less than or equal to 1 mg/l.	. Boating . Aesthetics . Swimming	. STP Effluent . Watershed runoff . Sediment release precipitation.	Precise loadings and flows unknown.
2. Bacteria	. Bacterial densities exceed provincial requirements for safe swimming on occasion.	. Swimming	. STP . Watershed runoff	Spacial and temporal extent of episodic bacterial elevation unresolved.
3. Metals and PCBs in sediments	. Sediments from some locations exceed provincial open water disposal guidelines. No evidence of biotic impairment or impact on edibility of sport fish.	. Open water disposal of sediments dredged for navigational purposes.	. Historical inputs from ship construction activities and other industrial inputs that are no longer active sources.	Confirmation that lead is not biologically available.
4. Contamination of fish flesh by mercury	. Advisory on yellow perch greater than 35 cm not attributed to local sources.	. Consumption of yellow perch (>35 cm) restricted.	. Outside of Area of Concern.	
5. Turbidity	. Inorganic turbidity reduces light penetration on occasion.	. Swimming	. Harbour sediments . Suspended sediments from inflows	Relative magnitude of sources and duration of impairment.

1. DESCRIPTION OF THE COLLINGWOOD AREA

Location and Watershed Characteristics:

Collingwood Harbour is situated in Georgian Bay on the south shore of Nottawasaga Bay (Figure 1). The adjacent Town of Collingwood, first incorporated in 1858, has a permanent population base of 12,000 (1985 statistics) and a sizeable population of seasonal residents. The town is serviced by a secondary type sewage treatment plant (STP) with phosphorus removal; treated effluent is discharged directly to the harbour. Collingwood Harbour was first identified as a "problem area" or "Area of Concern" in 1977 due to nuisance algal growth (IJC 1980).

The watershed is made up of two physiographic regions; the Niagara Escarpment region in the upper part of the basin and the Simcoe Lowlands region in the lower section which ends in a sand plain of beaches at the Nottawasaga Bay shoreline, within the larger Georgian Bay (Chapman & Putnam, 1966). The elevation difference between the top of the escarpment (locally known as Osler Bluffs or Blue Mountain), and Collingwood Harbour is approximately 360 metres.

The natural sandy beaches along Nottawasaga Bay, with shallow lakeward slopes, are characteristic of the nearshore reach which continues east to Wasaga Beach.

Collingwood Harbour receives tributary drainage from three small creeks. Black Ash Creek, the largest of the three, originates in the vicinity of Osler Bluffs and drains the surrounding agricultural area (Figure 1). A few in-stream and by-pass ponds have been constructed on Black Ash Creek for recreational use (Slaughter 1972) and plans are underway by the Nottawasaga Valley Conservation Authority to widen and berm the creek. The other two creeks, locally known as Oak Street Canal and Hickory Street Canal flow intermittently. Municipal storm sewers drain to these creeks, rather than directly to the harbour.

Soils in the drainage area are calcareous and vary in colour and texture (Figure 2). The area adjacent to the harbour consists of outwash sand, having good drainage. The mid-section of the drainage basin is a mixed variety of clay loam till, fine loamy sand, and loam and silt loam. The elevated upper section of the drainage basin includes the Niagara Escarpment, generally made up of a dolomitic cap rock overlain with glacial till moraines.

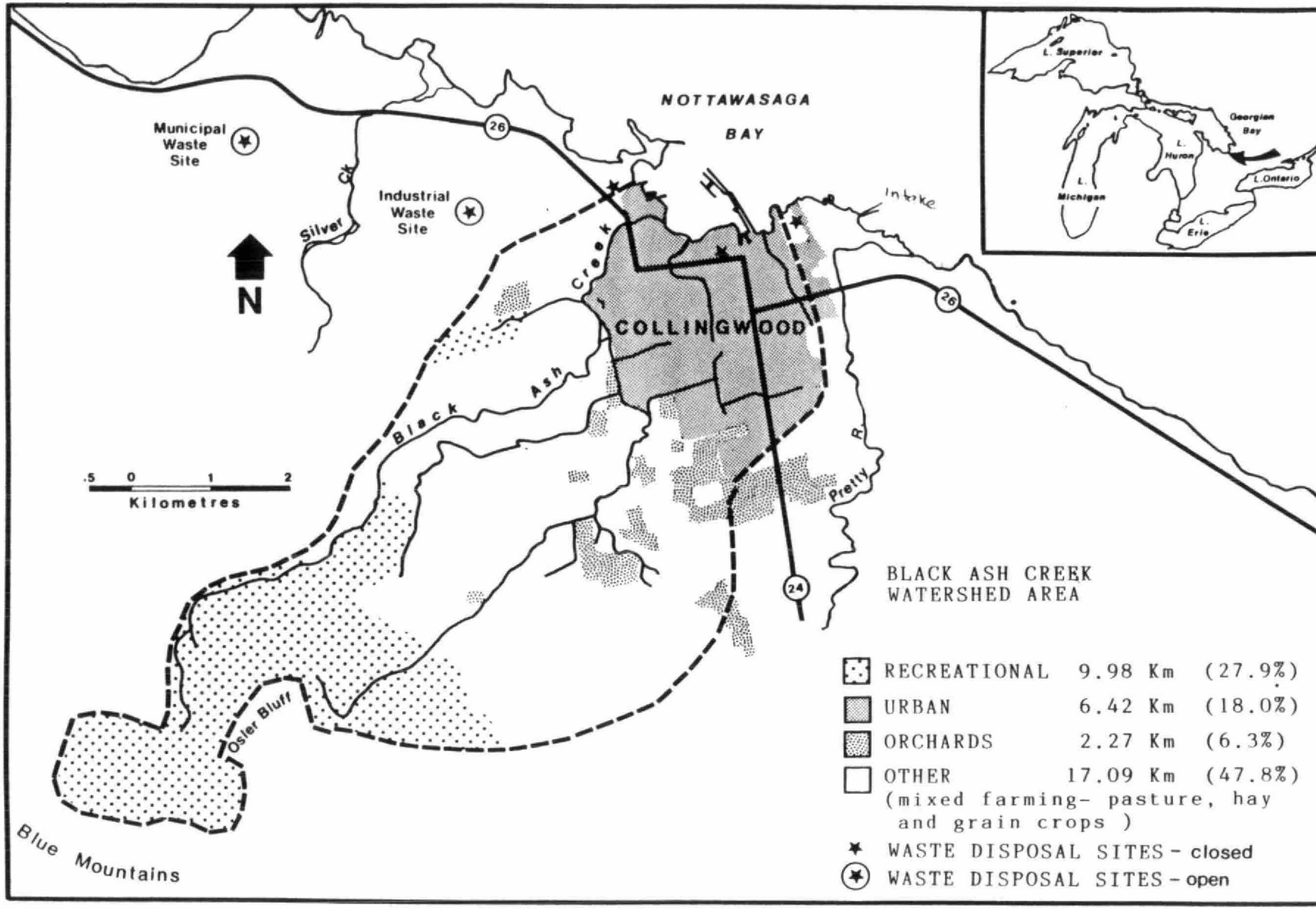


Figure 1: Land Use and Drainage Basin of the Collingwood Area.

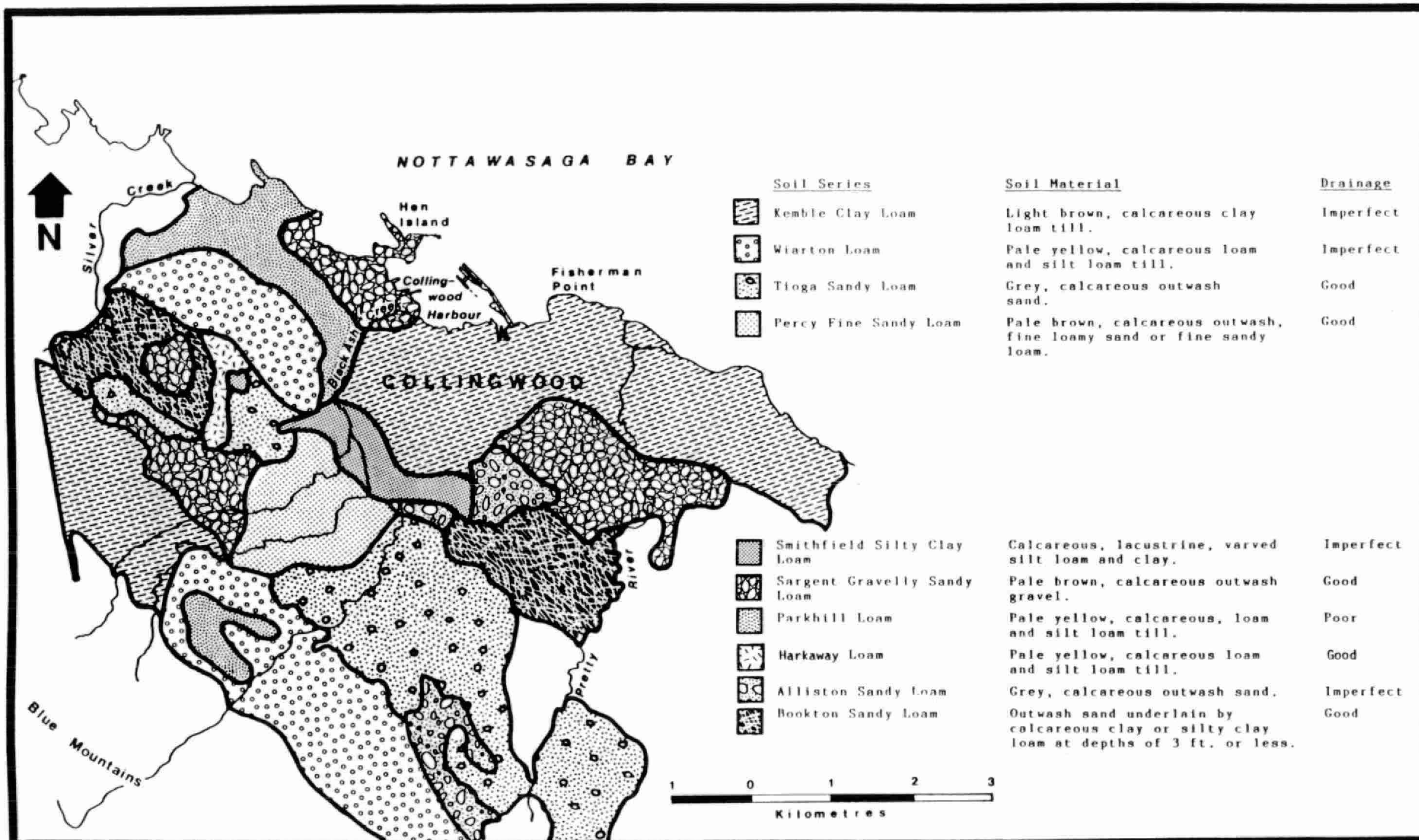


Figure 2: Soils of the Collingwood Area.

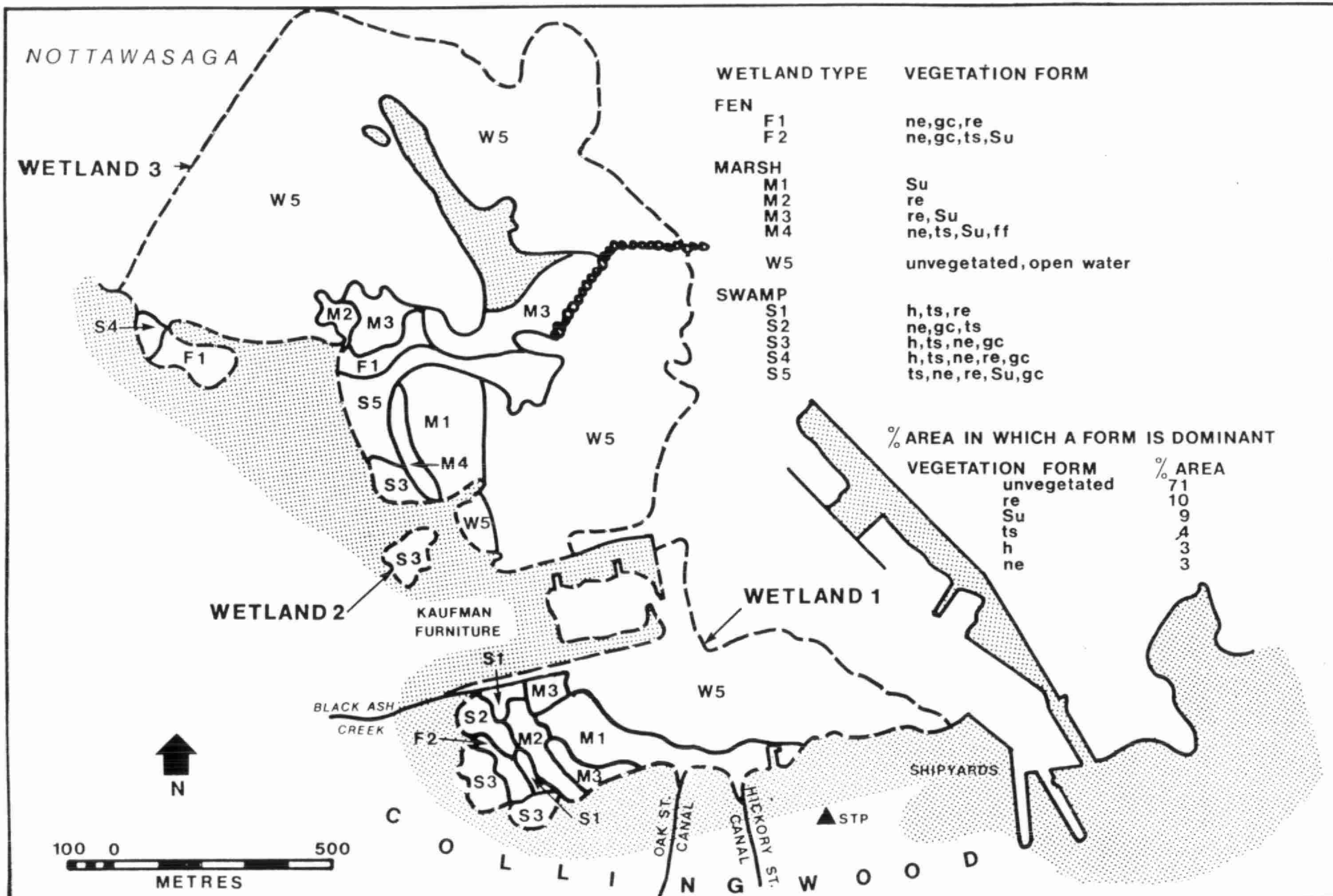


FIGURE 3: COLLINGWOOD HARBOUR WETLAND EVALUATION, 1986. (Source: MNR)

The nearshore area of Nottawasaga Bay outside of Collingwood Harbour, has been identified as a nutrient sensitive area. Strict controls of nutrient discharges are required (e.g. Long Point Sewage Treatment Plant at Mary Ward Shoals, west of Collingwood, is limited to 0.3 mg/L total phosphorus) to protect the shoreline from possible environmental degradation due to the growth of nuisance algae, especially *Cladophora* (Jackson *et al*. 1985).

Wetlands:

The Collingwood Harbour wetland was evaluated in 1986 and found to be a provincially significant Class II wetland. Three different types of wetlands were found in the complex including a fen, swamp and marsh (Figure 3). Five provincially significant bird species which utilize this wetland are the egret, common tern, Caspian tern, double-crested cormorant and black-crowned night-heron. The total area of the wetland is 96.4 hectares.

Harbour and Water Uses:

The current major uses of Collingwood Harbour include commercial shipping, its use as a receiving water body for the local sewage treatment plant's discharge, and recreational activities such as boating and fishing.

A small portion of the easterly region of the harbour is occupied by the Collingwood Yacht Club. According to the official plan, the east and south sides of the harbour are industrially zoned, whereas the west side of the harbour is designated as an Environmental Protection Area (public parkland). Collingwood Harbour's recreational facilities include two newly constructed marinas along the west shoreline of the harbour, adjacent to Kaufman's furniture plant and Cranberry Village, on the old Imperial Oil Wharf site (Figure 4). Both projects will require dredging upkeep in the future.

According to the Ministry of Natural Resources, fishing for rainbow trout and splake occurs in the harbour during the spring. Ice fishing for yellow perch is common in winter, while perch and bass are fished during the summer. Bass spawning areas have been identified on the west

side of the harbour. Some bass, however, have also been found in the eastern section where the dry docks are situated. Commercial and sport fishing is also carried out in nearby rivers and in Nottawasaga Bay outside of the harbour.

Land Uses:

The area surrounding Collingwood Harbour is a multi-use basin incorporating urban, agricultural, industrial and recreational land uses (Figure 1). The immediate vicinity of the harbour is comprised of the Town of Collingwood, characterized by urban, commercial and industrial activities.

Major industries in the area are or have been Collingwood Shipyards, (now closed) Kaufman of Canada (furniture making), Goodyear Hose Plant, Canadian Mist Distillers, Nacan Ltd. (cornstarch), Harding Ltd. (carpets), LOF Glass and Blue Mountain Pottery (Figure 4). Discharges from these industries are/were collected by the municipal sewage system and are treated at the sewage treatment plant which discharges to the harbour. Process changes at LOF Glass and the new Blue Mountain Pottery have eliminated discharges to the STP. Other activities along the periphery of the harbour involve handling and storage of hydrocarbon fuel and grains. To date, no spills from the fuel storage facility have been recorded.

The midsection of the watershed is primarily used for mixed farming and recreation, while the upper part of the basin consists mainly of agricultural and recreational land use.

There are five solid waste disposal sites within the Collingwood area (Figure 1). Three of the five sites are located within 200 m of the harbour and are closed (two sites were closed prior to 1965 and the third was closed in 1974). The two remaining sites are located outside the drainage basin approximately 2 km west of Collingwood Harbour. No known environmental problems have been associated with these sites to date.

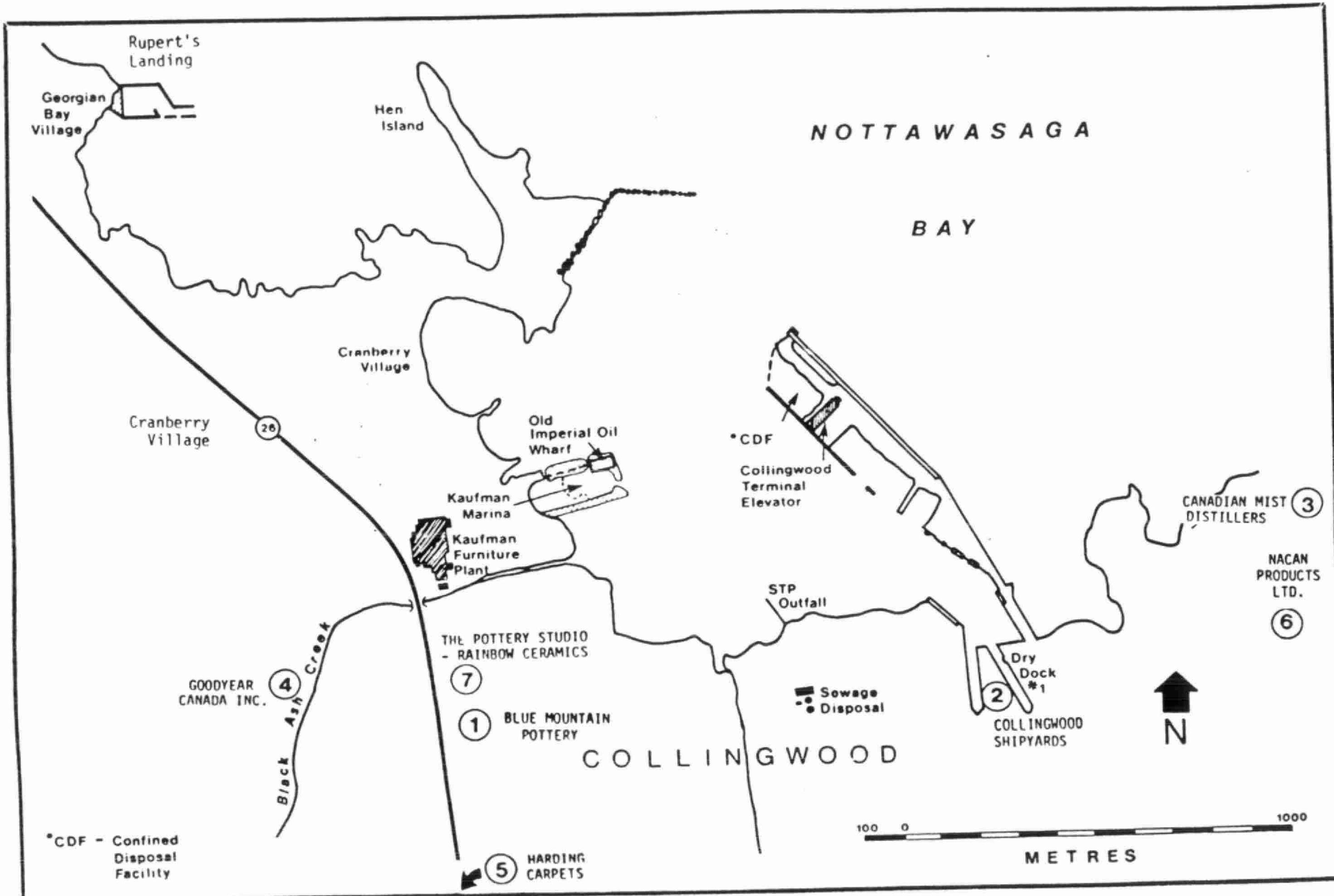


Figure 4: Collingwood's Industrial Community and Proposed Future Developments

2. DESCRIPTION OF ENVIRONMENTAL CONDITIONS

Physical Characteristics

Collingwood Harbour is relatively shallow with a maximum depth of 6.4 m (at datum) in the dredged portion of the 244 m turning basin. The harbour encompasses roughly 0.8 km^2 in area and has an approximate volume of 28.7×10^{-4} km^3. The entrance to the harbour is formed by two piers extending from shore. The breakwater pier on the western side of the harbour extends eastward 0.22 km. The eastern extension of the harbour pier runs in a northwesterly direction 1.02 km, resulting in a harbour entrance gap of 420 m.

The harbour is subject to prevailing winds and waves of long fetch originating from north to northeasterly directions. The shape and orientation of Collingwood Harbour are such that its mixing regime is affected by seiche effects and there is limited exchange with Nottawasaga Bay waters. Mixing within the harbour governs sediment resuspension and thus affects the quality of the harbour waters (Ross, 1977).

In 1986, a physical monitoring program using discrete measurements was carried out to assess the harbour's water movements and exchange rate with Nottawasaga Bay (MacLaren Plansearch, 1987). Sail drogues were released and tracked to provide discrete measurements of water movement across the harbour mouth. This study spanned 21 days from June to November, providing good opportunities to conduct measurements for a full range of wind and climatic conditions. Wind velocities ranged from calm conditions to speeds in excess of 30 KPH and water surface conditions ranged from calm to swells of 2.5 metres.

The exchange rate of water between Collingwood Harbour and Nottawasaga Bay was found to be affected by both natural and man-made influences. The principal driving forces of the exchange rate phenomenon were the wind-generated currents and the stream flows to the harbour. The breakwaters, piers and dredged channels significantly affected the speed and direction of the currents.

During the 21 day study, the residence time in the harbour was found to vary from a minimum of 0.30 days to a maximum of 33 days. Typically, however, the residence time was less than 3 days and only 30% of the surveys indicated residence times of longer duration. Generally, the residence time increased when northerly winds prevail and decreased when southerly winds prevail.

These flushing rates were estimated using discrete measurements to assume steady state conditions and should be considered as qualitative measures only. Typically, current meters are deployed to provide continuous time-varying flow measurements for these types of dynamic processes. Both the bathymetry of the harbour and shipping traffic prevented the use of conventional meters.

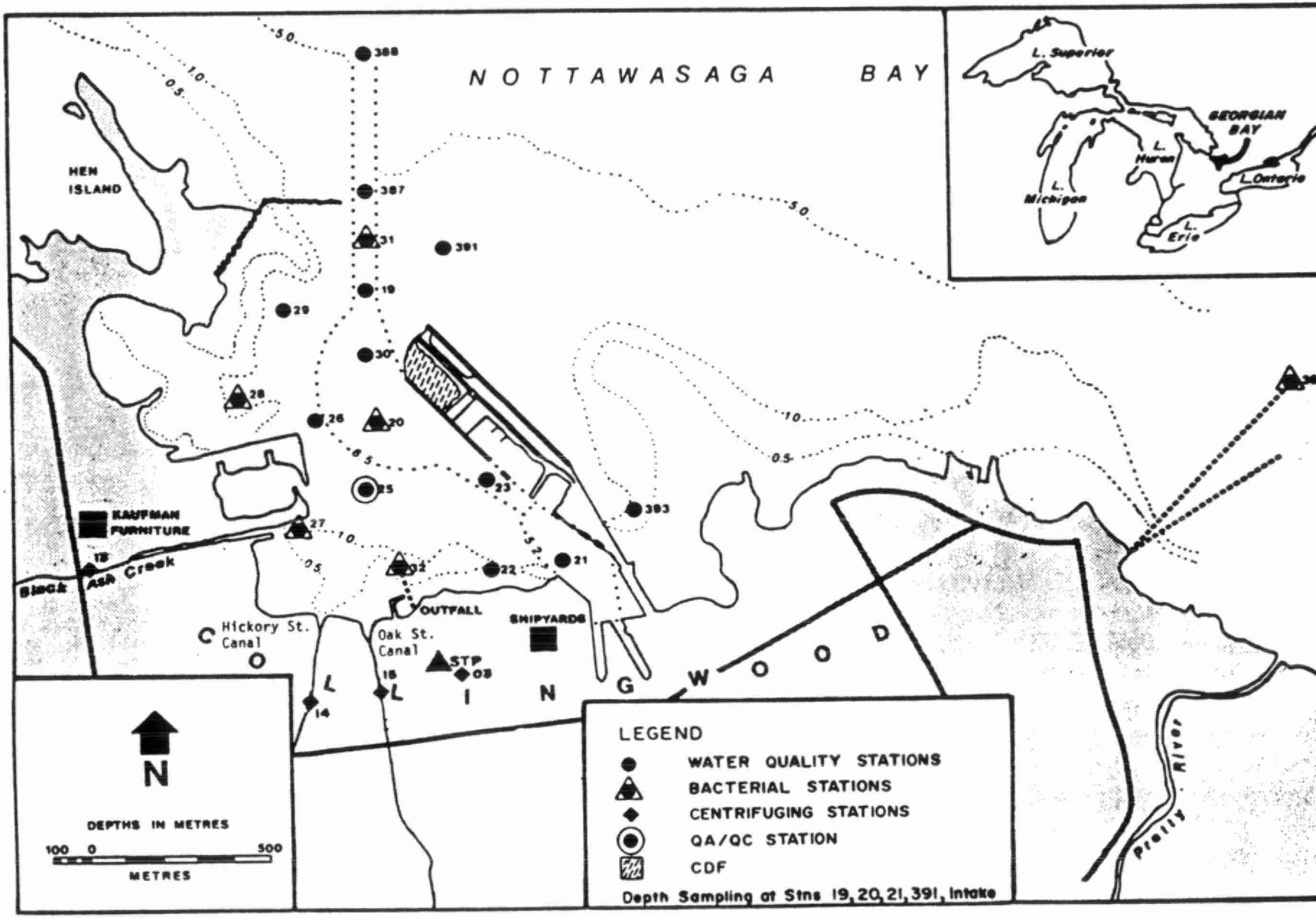


FIGURE 5: Collingwood Harbour location and stations for water quality surveys.

Water Quality

Although a decrease in phosphorus levels within the harbour has occurred since nutrient controls were introduced in the early 1970's, algal blooms still occur during the warm summer months. However, these algal blooms do not impact present use of the harbour in any way, other than by diminishing aesthetic value. Results of the 1980 and 1983 studies show that total phosphorus levels in Collingwood Harbour ranged from a mean of 153 ug/L at stn. 22, (Aug. 30-Sept.1, 1983) located between the STP discharge and the shipyards, to 11 ug/L at the harbour outlet (stn. 387, Sept. 1980). (See Figure 5 for station locations and Figure 6 for total phosphorus results.) Although phosphorus levels have decreased since 1974, results of surveys in 1980, 1983 and 1986 exceeded the Provincial Water Quality Guidelines (PWQG) of 20 ug/L, recommended to avoid nuisance algal growth. Expansion of the STP and the introduction of a secondary treatment facility has resulted in significant improvements in effluent quality (Table 11). By 1987, effluent quality no longer exceeded the PWQG effluent requirement of 1 mg/l specified in the GLWQA (1983).

Water clarity in Collingwood Harbour is poor based on secchi disc readings (Figure 8). This is typical of harbours throughout the Great Lakes. The curve in Figure 7 indicates the level of chlorophyll a related to the secchi disk depth observed for many recreational lakes in Ontario. Since all points fell below this curve, it is clear that turbidity is partially due to suspended inorganic matter (Figure 8). A secchi depth of 1.2 m or greater is required for safe swimming (PWQO). This objective was not met at most stations within the harbour. Secchi disk depths can be strongly influenced by storm events that increase turbidity and algal growth varies seasonally. The high turbidity measurements reported for 1986 may, in fact, be linked to storm events. It is likely that at some points in time, secchi disk depth will exceed 1.2 m within regions of the harbour.

Through studies conducted in 1974, 1980, 1983 and 1986, MOE collected a limited number of samples for bacteriological enumeration. Data from the 1980 study (July and August) indicated levels of fecal coliform bacteria above the PWQO for swimming and bathing of 100 counts/100 ml at a number of sites within Collingwood Harbour.

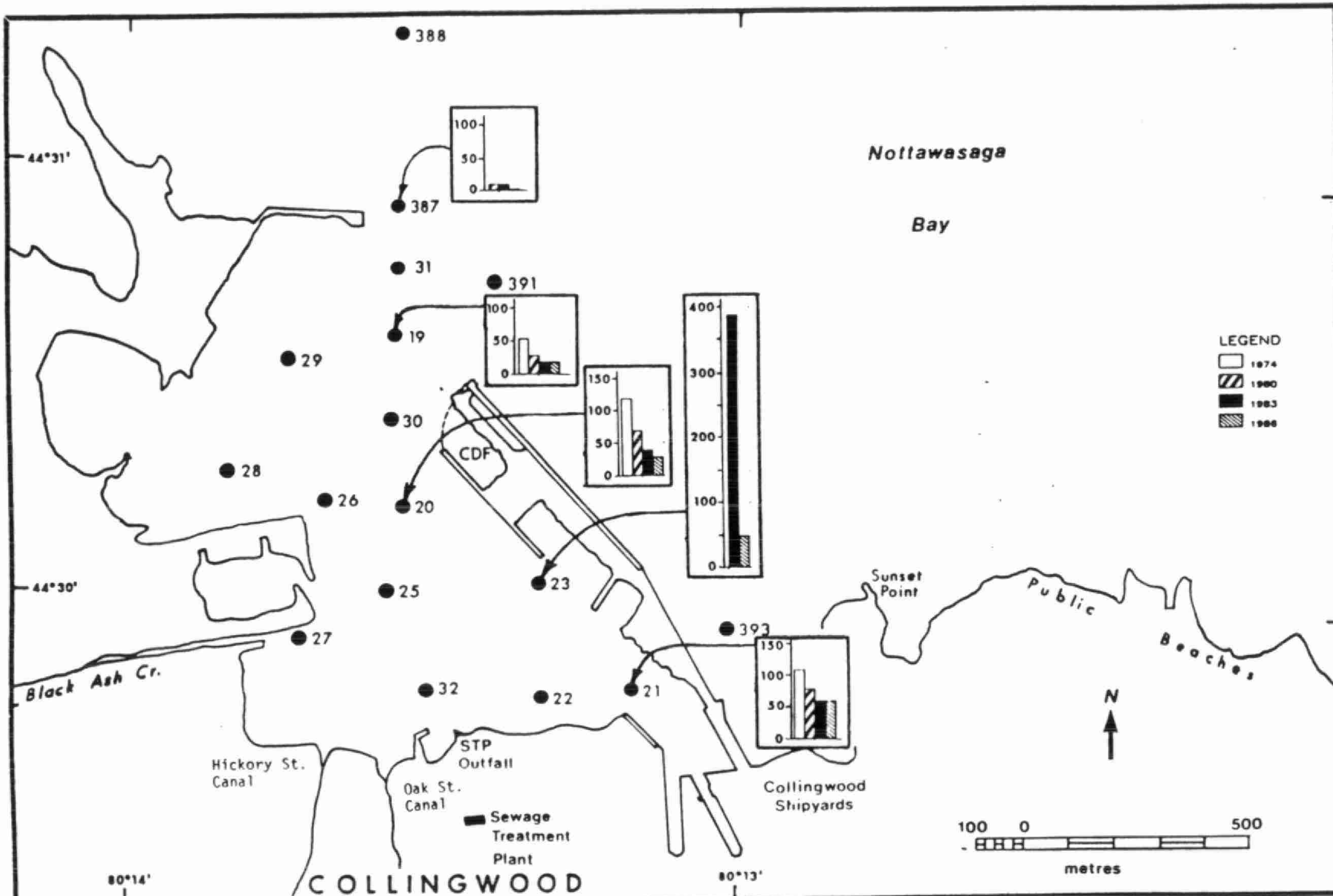


FIGURE 6: Phosphorus concentrations (ug/l) in Collingwood Harbour, 1974 - 1986

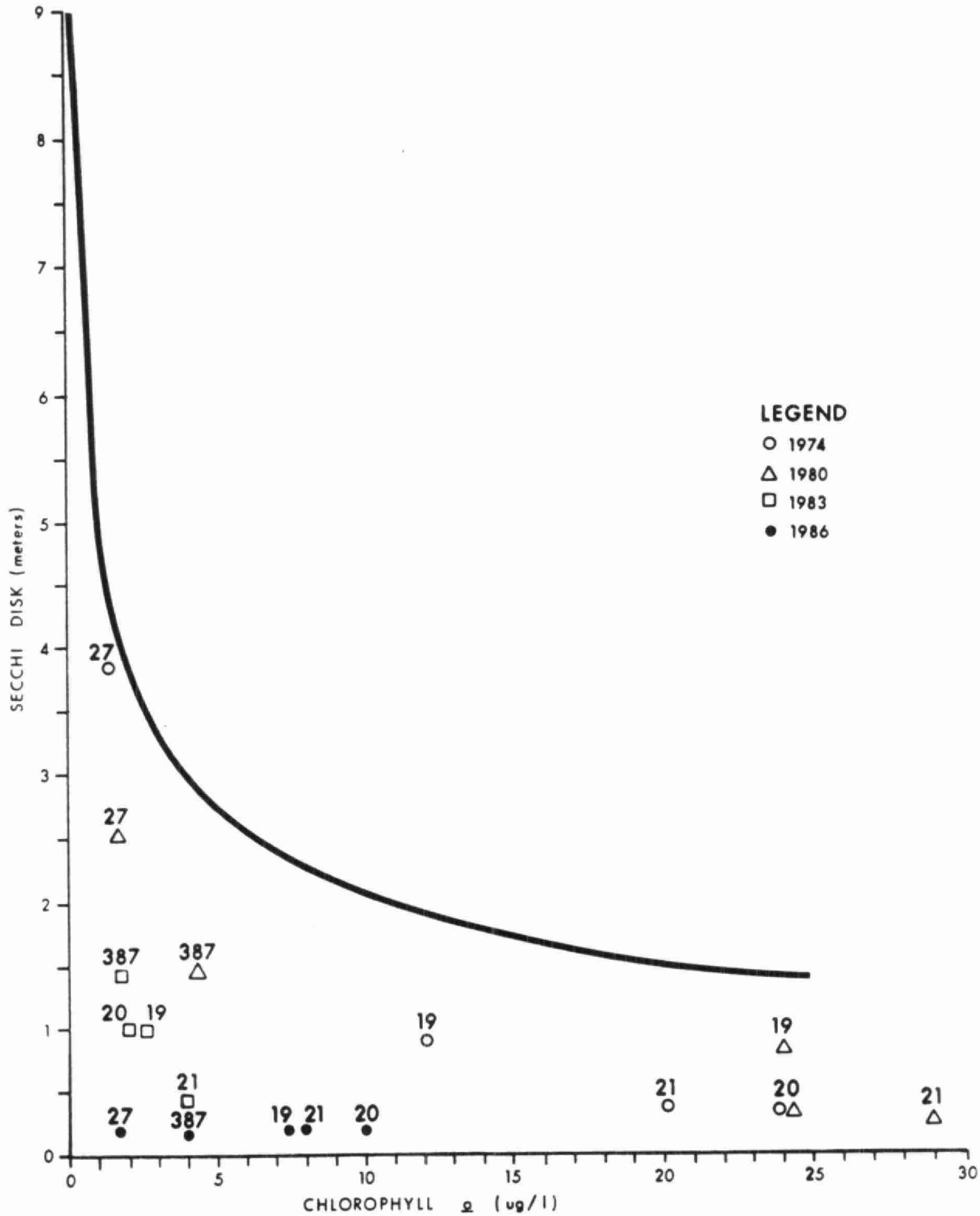
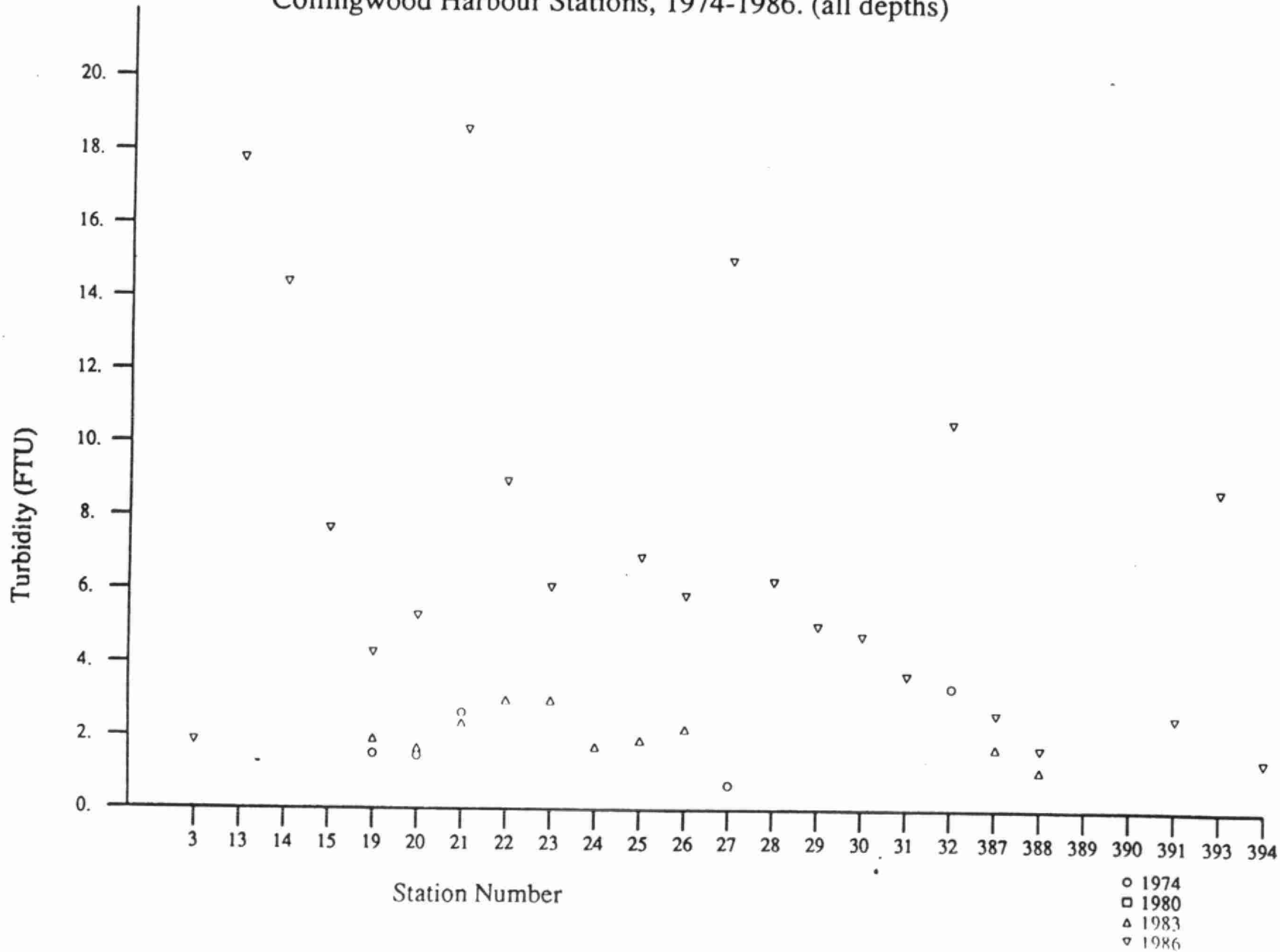


FIGURE 7: The relationship between Chlorophyll a and Secchi disk depth for stations sampled in September 1974 - 1986 (values for 1986 are for Chlorophyll a only). Secchi disk depth greater than 1.2 m meets the provincial objective for safe swimming.

Figure 8 Annual Mean Concentrations of Turbidity for Collingwood Harbour Stations, 1974-1986. (all depths)



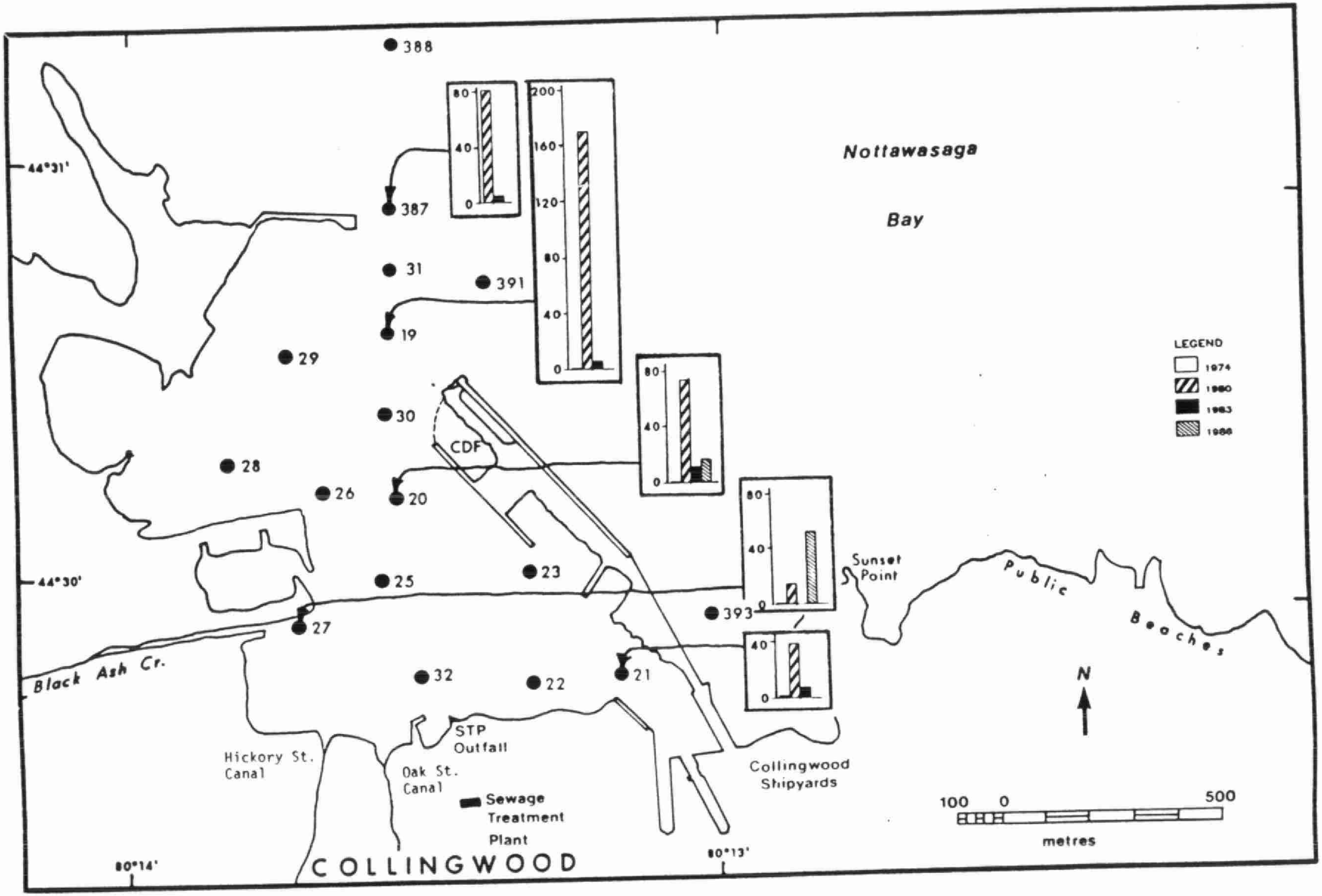


FIGURE 9: Mean densities of Fecal Coliforms (#/ml) in Collingwood Harbour, 1974 - 1986

Data from the 1983 study (June and August) indicated generally improved conditions with bacteria levels below the PWQO at most sites. Preliminary results from a survey conducted in 1986 indicated that most sites sampled met the PWQO for swimming and bathing.

Ideally, a series of at least 10 bacteria samples per month is recommended to test for water quality impairment (MOE, 1984). Since sampling was not intended to address requirements for swimming and bathing (usually three samples per month were collected), the trends demonstrated are considered qualitative only. As such, bacterial data in the harbour and from the potential sources is sparse. A thorough bacteriological survey is therefore being planned for 1989. It is anticipated that this survey will identify source loadings and receiving water conditions through both dry and wet weather periods.

Sediment

Sediment quality was examined in 1974, 1983, 1986 and 1987. The study conducted in 1987 assessed whether sediment quality changed following dredging operations in the turning basin of the harbour. Sediment assessment is a critical component of the RAP evaluation process because contaminants in sediments can potentially affect aquatic biota.

Contaminants in sediments can accumulate in bottom dwelling and bottom feeding organisms resulting in either direct effects on the organism, or movement of the contaminants into the food web.

The 1986 and 1983 surficial sediment survey by the Ministry of the Environment suggested improvement over the 1974 investigation; however, parameters such as of PCB's, zinc, lead, chromium, copper, iron, total phosphorus and total Kjeldahl nitrogen still exceeded the provincial guidelines for open-water disposal of dredged material (Figures 10, 11, 12). These guidelines are not designed to identify the level of toxicity in sediments, but are generally based on lakewide historical levels of various substances. Biological testing of these sediments is therefore necessary in order to determine their environmental significance. Comparisons of sediment chemistry for 1974, 1983 and 1986 are presented in Figures 10, 11 and 12. The 1986 pre-dredging and 1987 post-dredging data are presented in Tables 1 and 2.

Contaminant levels exceeding the guidelines were generally within two times the allowable concentrations. In 1987, 8 stations of the 12 sampled, showed acceptable levels of PCB's. All stations had Cd, Hg and Ni levels below the guidelines; 10 had Pb and Zn concentrations below the guideline and Cu and Cr were below the guideline in 9 and 8 stations, respectively. Improvement may be attributed to sediment transport out of the harbour and into Nottawasaga Bay, dredging and disposal of the contaminated sediments from the navigational area, and more recent burial of contaminated sediment by cleaner sediments.

In July of 1986, 19 stations in Collingwood Harbour were surveyed by the Ministry of the Environment. The study encompassed several components, including surficial sediment (top 3 cm) chemistry, bottom water (1 m off bottom) chemistry, contaminants in native benthic invertebrates and bottom-feeding fish (sculpins) and benthic community structure. The stations were grouped into three areas: inside the harbour - nearshore (27, 28, 32), inside the harbour - turning basin and docks (19, 20, 21, 22, 23, 25, 26, 30, 30A, 387, 393, BPR) and outside the harbour (394, 395, NI, CR) (Figure 5, Table 3). The field and laboratory methods followed those of Persaud et al, 1987.

The 1986 sediment results indicate that the stations located inside the harbour nearshore (near the bay) were cleaner than other stations inside the harbour. Parameters such as nutrients and metals in surficial sediments were below the Provincial Guidelines for Open Water Disposal of Dredged Material, except at station 32 where the solvent extractable (oil and grease) concentration was slightly above the Guideline. Detectable levels of PCB, ppDDE, hexachlorobenzene (HCB), and octacholorostyrene were found at station 28. At the other two stations, ppDDE and HCB were detected in the sediments at low concentrations. There are currently no sediment guidelines for these compounds.

The contaminants in surficial sediments collected from inside the harbour in the turning basin and near the docks were elevated, relative to the other two areas. Most stations exceeded the Provincial Guidelines for phosphorus, copper, chromium and iron. Several stations had levels of total Kjeldahl nitrogen, lead, zinc and solvent extractables that exceeded the Provincial Guidelines. Manganese, aluminum, PCB, ppDDE and heptachlor epoxide were detected at most stations. At several stations, there were dieldrin, DDT, endosulfan I, II, endrin, ppDDE and octachlorostyrene were detected in surficial

sediments. These contaminants are more likely to occur at these sites because the turning basin is a depositional zone with fine (mainly silt and clay particle size) material and contaminants tend to be associated with fine (silt and clay) sediments.

Sediments at Station 395, located near the historic open water disposal site outside the harbour were relatively clean with only slightly elevated levels of solvent extractables.

In 1986 a chemical extraction procedure was carried out on 13 sediment samples from the harbour. Concentrations of various forms of phosphorus in the sediment were determined by individual extractions. These extractions permit the estimation of the amount of phosphorus that is biologically available (nonapitate phosphorus), and the amount that is in an unavailable form (apitate phosphorus). Phosphorus uptake by algae is dependent on the quantity of nonapitate inorganic phosphorus in sediment, since phosphorus in the form of apitate is not biologically available to algae (Williams et al. 1980).

The data from Collingwood Harbour indicate that a large portion of sediment associated phosphorus is in an available form, and consequently, would support algal growth. Given the concern over algal growth in the harbour, it is evident that sediment must be considered as a source of phosphorus. Phosphorus in sediments with a high concentration of sand appears to be in apitate form and not available to algae.

The approach channel to the harbour was found to meet open water disposal guidelines when dredged by Public Works Canada during the summer and fall of 1985. Dredged materials were disposed of in open waters of 15 metres depth in Nottawasaga Bay. The shipyard area was also dredged in 1985, removing contaminated silt and bedrock which was disposed of on shore. The harbour proper (turning basin), was dredged in the fall of 1986. Dredged material was placed in the new confined disposal facility built near the grain elevators, at the harbour mouth.

The 1987 sediment survey revealed that concentrations of metals, trace organics and nutrients for most stations were lower than those measured in 1986. In 1986, sediments at 8 stations had compounds that exceeded the MOE guidelines for open water disposal. This number was reduced to 5 by 1987, and of those 5, fewer compounds were in excess of the

guidelines (Tables 1 and 2). A summary of sediment data for all years is provided in Appendix 1. In March-October, 1986, suspended sediments were collected at the sewage treatment plant outfall (station 3), Black Ash Creek (station 13), and the storm drains at Oak Street (station 14) and Hickory Street (station 15) Canals. A detailed list of metal and organic compound concentrations is provided in Appendix Ib. Appendix Ic provides a summary of the relative magnitude of each of these sources to harbour loading. At the sampling dates specified, the STP was by far the most significant source of P to the harbour. A considerable component of metal input to the harbour could be attributed to Black Ash Creek. The highly variability in loadings is reflective of flow regimes, and at low flows, virtually no metal input occurs via suspended solids.

An additional consideration in assessing the significance of suspended sediments inputs for metal loading in the harbour focuses on the extent of mixing of harbour waters with the Bay. Depending on wind direction and speed, suspended sediments entering from these inflows could be carried into the Bay with little likelihood of settling within the harbour.

TABLE 1: **MEAN CONCENTRATIONS OF METALS, PCBS AND OIL AND GREASE IN COLLINGWOOD HARBOUR SEDIMENTS PRE-(1986) AND POST-(1987) DREDGING**
All values are in parts per million (ug/g) except for PCBs (parts per billion; ng/g)

Station	YEAR	PCBs	Cd	Cr	Cu	Hg	Ni	Pb	Zn	Fe	Oil and Grease
19	1986	66*	0.46	22	25	0.07	12	34	53	11025*	1093
19	1987	<43	0.54	25	25	0.06	13	30	59	12000*	519
20	1986	65*	0.64	30*	41*	0.12	17	58*	97	13500*	2875*
20	1987	93*	0.61	24	31*	0.08	15	45	83	14000*	1187
21	1986	192*	13.5*	36*	72*	0.24	19	133*	195*	17000*	3175*
21	1987	160*	0.77	31*	59*	0.12	17	110*	190*	16500*	2509*
22	1986	55*	0.33	18	26*	0.11	9	48	69	9300	2370*
22	1987	<20	<.28	17	16	0.13	6	29	57	7400	9027/280
23	1986	103*	0.62	28*	49*	0.23	16	79*	115*	15000*	4700*
23	1987	105*	0.60	29*	38*	0.13	16	80*	120*	15000*	1162
25	1986	40	0.42	18	25	0.12	10	34	51	10200*	2450*
25	1987	<20	0.39	19	14	0.03	6	20	40	8600	2191[1]
28	1986	33	0.38	17	22	0.09	10	25	46	9150	2250*
28	1987	<20	0.43	23	24	0.04	13	32	65	12500*	2499*
30	1986	93*	0.61	27*	43*	0.14	18	56*	94	15500*	2018*
30	1987	<53*	0.71	27*	33*	0.08	14	44	76	14000*	833
32	1986	22	0.22	14	7	0.03	4	10	19	7156	934
32	1987	<20	0.31	16	10	0.02	5	13	29	7200	319
387	1986	<20	0.29	18	19	0.02	11	10	26	10350*	2612*
387	1987	<20	0.45	20	15	0.01	10	10	30	9400	530
388	1986	<20	0.26	15	9	0.03	6	5	10	21240*	596
388	1987	<20	<.30	15	6	<0.01	4	6	12	7000	142
393	1986	<20	0.32	11	11	0.06	4	14	31	6450	1468
393	1987	<20	<.30	16	10	0.02	6	14	35	7700	487
MOE Dredging Guideline		50	1.0	25	25	0.3	25	50	100	10000	1500

* exceeds MOE guidelines
[1] coefficient of variation = 149%; tentative value

TABLE 2: PHYSICAL PROPERTIES AND NUTRIENT LEVELS IN COLLINGWOOD HARBOUR SEDIMENTS PRE-(1986) AND POST-(1987) DREDGING

Station	YEAR	TKN (mg/g)	P (mg/g)	TOC (mg/g)	Sand (%)	Silt (%)	Clay (%)
19	1986	1.1	1.0	20	0.6	43.2	55.9
19	1987	1.2	0.9	17	0.9	39.7	59.2
20	1986	1.9	1.7*	30	2.0	24.0	79.3
20	1987	1.2	1.1*	17	<0.2	9.5	90.1
21	1986	2.2*	2.3*	27	0.2	13.4	86.4
21	1987	1.6	2.1*	27	<0.1	49.6	50.2
22	1986	1.2	1.5*	16	0.1	69.5	30.5
22	1987	0.7	0.9	7	<0.1	83.3	16.5
23	1986	2.1*	2.7*	30	0.1	25.0	74.9
23	1987	1.5	1.6*	23	<0.2	21.4	78.3
25	1986	1.3	1.2*	15	2.0	50.6	47.4
25	1987	0.4	0.7	6	1.4	77.3	21.2
28	1986	1.6	0.8	17	0.2	56.5	43.3
28	1987	1.5	0.9	21	0.1	35.3	64.5
30	1986	2.0	1.6*	27	0.5	34.5	64.9
30	1987	1.1	1.0	16	0.1	8.0	91.9
32	1986	0.4	0.6	6	0.2	90.4	9.4
32	1987	0.5	0.6	6	0.1	84.8	14.9
387	1986	1.0	0.6	13	0.1	63.4	36.5
387	1987	0.9	0.5	10	<0.1	66.2	33.6
388	1986	0.6	0.4	11	4.4	51.8	43.3
388	1987	0.3	0.3	11	2.9	80.3	16.7
393	1986	0.8	0.5	10	0.2	83.4	16.4
393	1987	0.8	0.5	12	0.1	83.1	16.6
MOE Dredging Guideline		2.0	1.0	**	-	-	-

* exceeds MOE guidelines
**guideline does not exist

TABLE 3: MEAN CONCENTRATIONS OF METALS, AND ORGANIC COMPOUNDS IN SEDIMENTS (ug/g) AND MEAN PARTICLE SIZE FRACTIONS (%) BY STATION GROUPS[1] IN JULY 1986 FOR THOSE PARAMETERS SHOWING SIGNIFICANT DIFFERENCES[2] IN SEDIMENT QUALITY BETWEEN STATION GROUPS[4]

	Mean Values - Station Groups					Dredging Guidelines[3]
	1	2	3	4	5	
Al	5,973	3,250	3,533	9,375	3,450	-
Cd	0.35	0.2	0.25	0.60	0.22	1
Cr	17.5	10.4	11.7	28.2+	17.4	25
Cu	21.9	8.7	8.8	51.9+	9.6	25
Fe	9,665	5,925	6,584	15,080+	6,711	10,000
Hg*	0.08	0.05	0.05	0.19	0.06	0.3
Mn	313.6	180	216.7	410	225	-
Ni	9.6	3.1	4.05	16.3	3.8	25
Pb*	23.8	10.4	6.7	72.9+	18.4	50
Oil and Grease	1,922	837	1,097	3,469+	1,321	2,000
Total Organic Carbon	15.1	22.5	7.4	27.4	5.3	-
Zn	33.0	15.7	9.8	117.0+	10.3	100
PCBs	0.0371	0.0224	0.020	0.0935+	0.020	0.05
p,p-DDE	0.0045	0.002	0.001	0.0105	0.001	-
Silt	57.3	66.3	86.7	27.8	0	
Clay	41.8	13.0	30.6	71.3	100	

[1]Station Group	Station Numbers	Harbour
1	19, 22, 25, 28, 387	Harbour
2	32	Opposite STP
3	388, 393, 394	Nottawasaga Bay
4	20, 21, 23, 30	Shipping Channel
5	391	Nottawasaga Bay

[2] $p<0.05$, as determined by One-Way Analysis of Variance

[3] Persaud and Wilkins (1976)

[4] Station groups determined by cluster analysis, with the exception of station number 32. Station 32 removed from cluster due to unique location, at the STP outfall.

* These parameters show significant differences within station groups ($p<0.05$)

+ Dredging guidelines exceeded

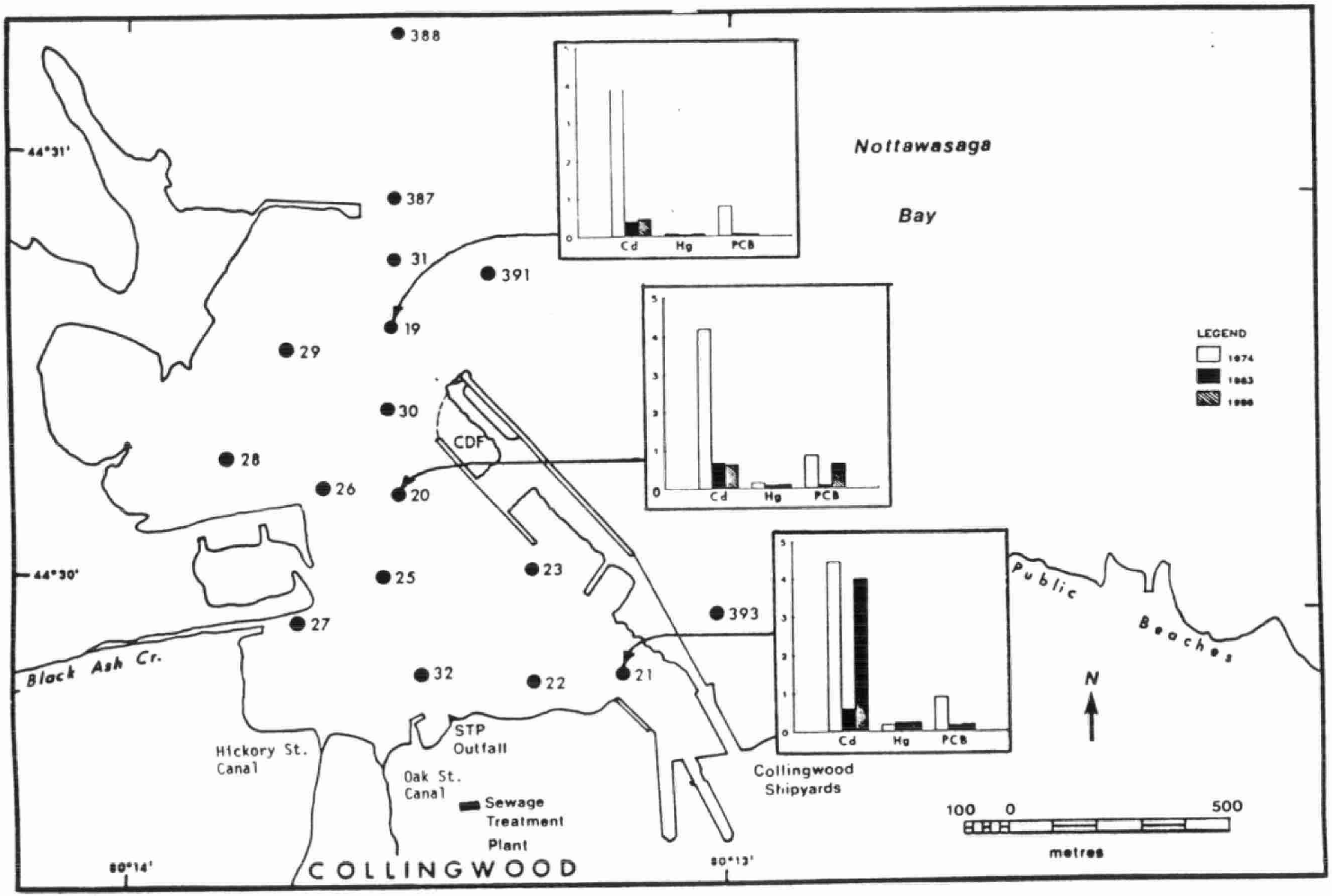


FIGURE 10: Cadmium, Mercury and PCB's in sediments (ug/g) in Collingwood Harbour, 1974 - 1986

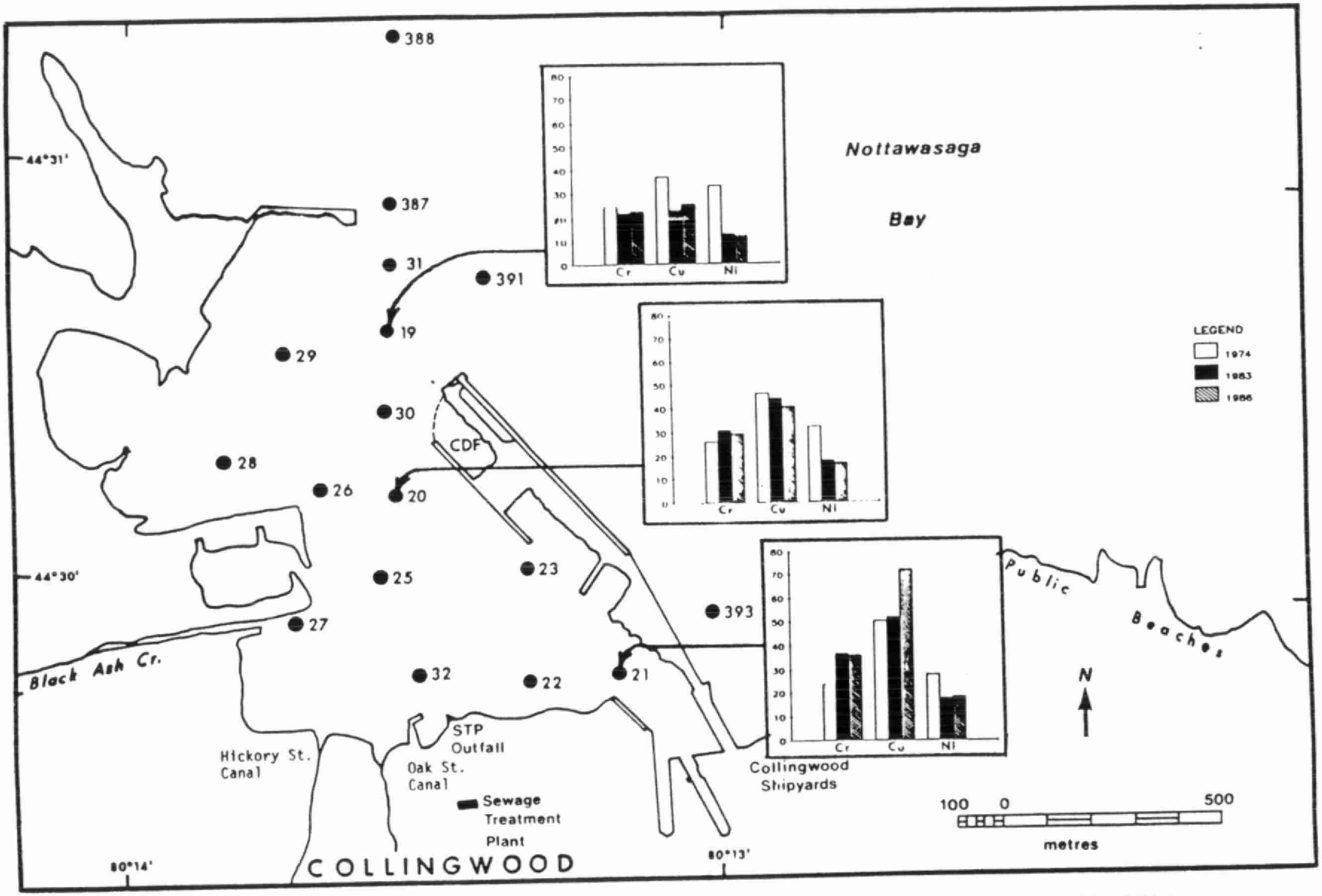


FIGURE 11: Chromium, Copper and Nickel in sediments (ug/g) in Collingwood Harbour, 1974 - 1986

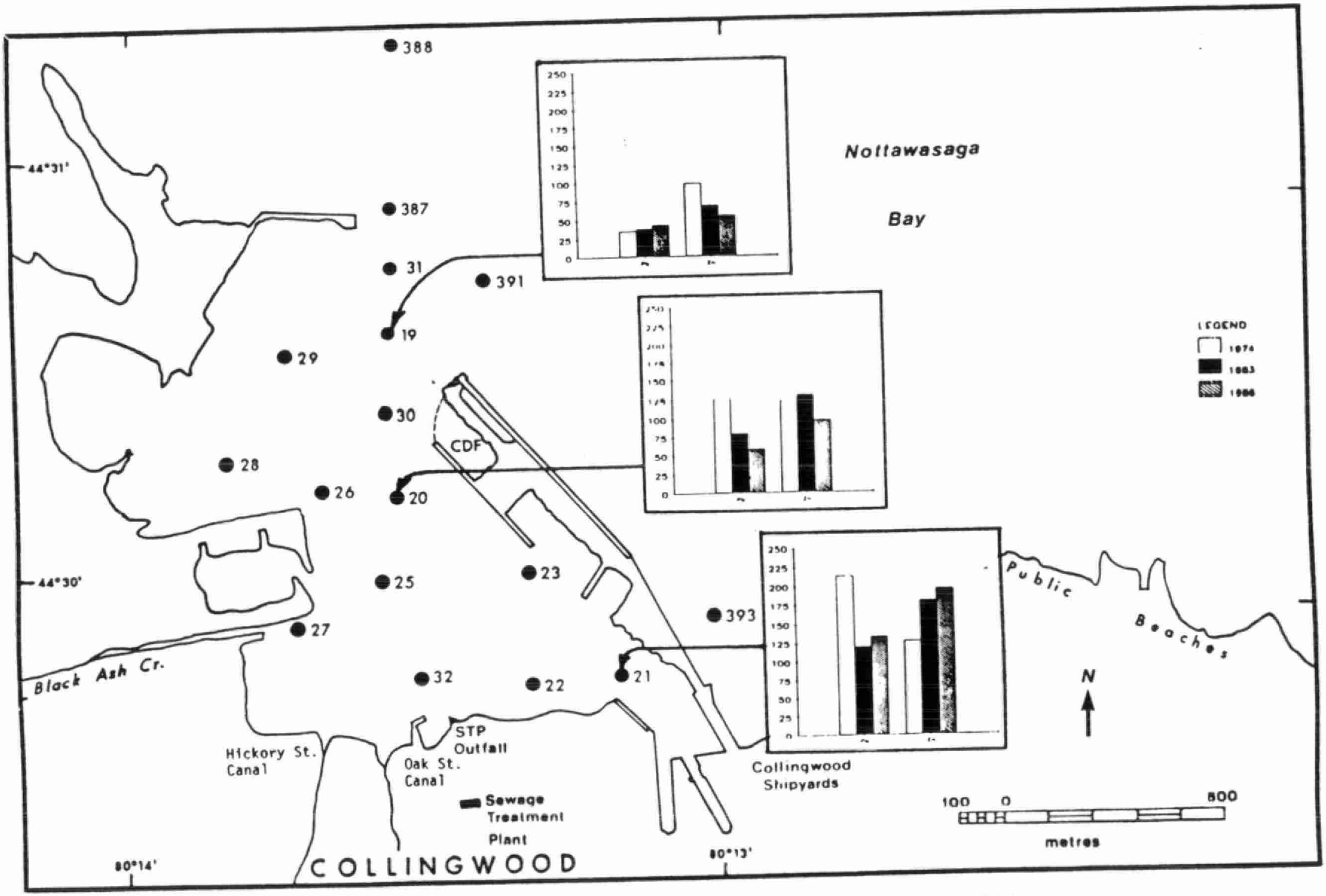


FIGURE 12: Lead and Zinc in sediments (ug/g) in Collingwood Harbour, 1974 - 1986

Biology

Algae:

Nuisance algal growth has long been identified as an aesthetic problem in Collingwood Harbour due to nutrient loading. Results of a MOE 1983 study found that chlorophyll a during May 31 - June 2 were greater than two previous year's surveys. However, chlorophyll a values for August 30 - Sept. 1 in 1983 were lower than those found in 1980 and 1974, Figure 7.

In 1986 a short-term algal test was carried out using portions of the natural phytoplankton community. The objective was to determine the algae phosphorus relation at different stations across the harbour and to qualitatively assess any inhibitory influence of toxicants present in the STP effluent on algal growth potential and community structure. This "caged" phytoplankton method (Nicholls and Heintsch 1987) permits the exchange of dissolved materials between the ambient water and the enclosure, and also exposes a known portion of the indigenous algal community to the ambient conditions of the site for several days.

The 4-day experiment was conducted between Oct. 20 and Oct. 24, 1986 at four stations during a non-chlorination period. The harbour stations, positioned along the anticipated effluent gradient were: station 32 outside the STP outfall; station 25 in the inner harbour; and station 19 near the harbour mouth. Station 394 opposite the water intake plant was used as a control station, and as a source of the inoculum. At this open water station the algae were not considered to be influenced greatly by antropogenic perturbations.

There was an apparent phytoplankton biomass response to increased phosphorus concentration at all three stations in the harbour (Fig. 13). The highest biomass was detected near the STP outfall (station 32) and corresponded with the highest average phosphorus concentration. Therefore, phosphorus in the harbour water is in a form that is available for algal uptake and growth.

There were no major differences in phytoplankton community taxonomic composition among stations, and species composition at the end of 4 days incubation was similar for all stations.

Cladophora studies in the Collingwood area carried out in 1979-80, found that growth was restricted to the mouth of the harbour and at the boat launch (near the STP discharge). This was expected as a result of high turbidity, restricted harbour water movement and lack of suitable substrate. Biomonitoring investigations using filamentous algae were also carried out at this time to determine nutrient and heavy metal bioconcentrations indicative of recent water quality. Algae are a useful monitor of water quality since they accumulate measurable levels of contaminants that may be undetected in the water column. They can therefore indicate the presence of biologically available contaminants, although absolute concentrations of these substances in algae is not a direct measure of environmental impact. Results from 1979-1980 at stations located inside and outside Collingwood Harbour ranged from 38.4-124.6 ug/g (Zinc), 2.0-120.0 ug/g (Lead), <0.01-<0.04 (Mercury) and 1.4-5.6 mg/g (Total Phosphorus). Results for the 1986 study of contaminants in *Cladophora* found values for zinc, lead, mercury and Total phosphorus that ranged from 8.1-39.3 ug/g, 1.4-14.6 ug/g, <0.01 ug/g, and 0.7-4.0 ug/g, respectively.

While there were apparent decreases in contaminant levels in *Cladophora* in 1986, these may not be significant since the 1986 study consisted of a single sampling day, while the 1980 study consisted of multiple sampling days. Samples collected at a single point in time may reflect water quality at that time but may not adequately characterize long-term fluctuations in water quality.

Benthos:

Benthic community structure results of the 1986 study by MOE (Table 4) showed that stations inside the harbour were mainly eutrophic (organic enriched) and that the predominant organisms were pollution tolerant (oligochaetes and chironomids). Outside the harbour there were few benthic organisms and this was attributed to unsuitability of the substrate which consisted of coarse sand or rocks. Substrate quality appeared to be the limiting factor outside the harbour and along the nearshore of the harbour. In the inner harbour, organic content of the substrate may also have influenced benthic community structure.

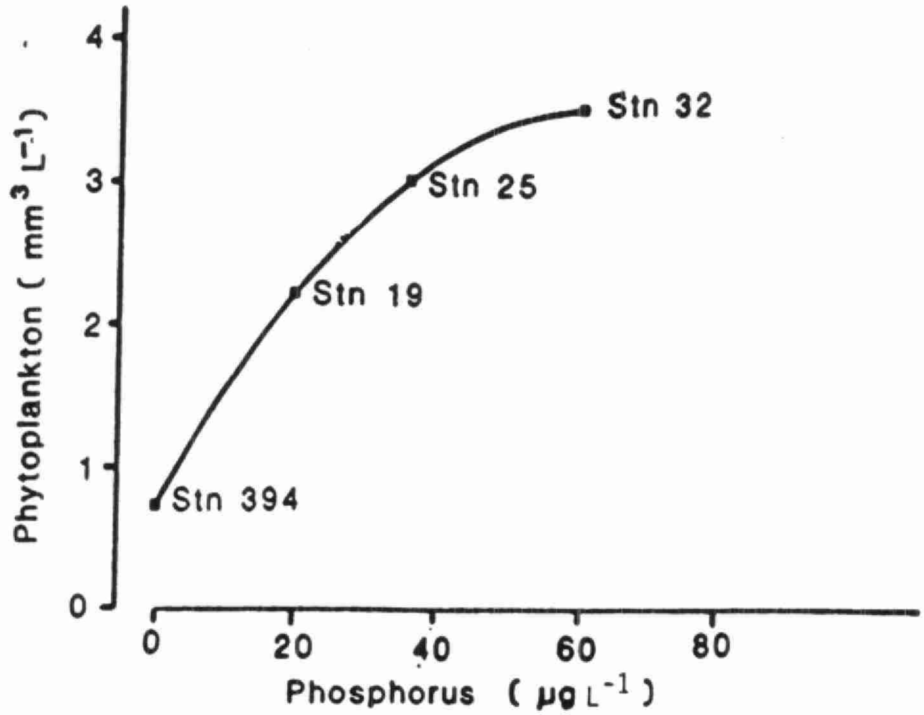


Figure 13. Phytoplankton biomass (mm^3 L^{-1}) after 4 days incubation, and ambient water phosphorus concentrations at three stations in Collingwood Harbour, and at the control statrion (Stn 394).

TABLE 4 DENSITY AND DISTRIBUTION OF MACROBENTHIC TAXA, COLLINGWOOD HARBOUR, JULY 1986.

SPECIES	STATION NUMBER (#/m²)														
	21	22	23	32	27	A	20	26	28	30	19	387	395	394	393
EPHEMEROPTERA															
Ephemeridae: Hexagenia limbata												19			
Caenidae: Caenis sp.									19						57
DIPTERA															
Chironomidae:															
Chironomus sp.				249							306		10		
C. plumosus group		19	19		1,494			172	651	287		1,226			306
Cryptotendipes sp.									230			77			
Cladopelma sp.				38			19			77					
Dicrotendipes sp.															153
Endochironomus sp.															1,168
Polypedilum (Tripodura) sp.										19		115			
Tanytarsus sp.								19							57
Procladius sp.			19	19			19	38		19	38	77			
AMPHIPODA															
Gammaridae:															
Gammarus fasciatus									19				10		
G. lacustris															96
ISOPODA															
Asellidae: Asellus sp.									19			19			
DECAPODA															
Orconectes sp.	38														
GASTROPODA															
Hydrobiidae: Amnicola limosa									19						
Planorbidae: Gyralus parvus									19						
PELECYPODA															
Sphaeriidae:															
Pisidium casertanum									77						
HIRUDINEA															
Helobdella stagnalis		19													
OLIGOCHAETA															
Tubificidae:															
Aulodrilus pleuriseta										287					
Ilyodrilus templetoni											96				
Limnodrilus cervix	268	1,302	383	77	843		96	230	881	191	191	19			
L. claparedianus			96					938		287					
L. hoffmeisteri	2,413	900	287	785	345		345	1,053	632	575	689	38			555
L. udekemianus															57
Potamothrix moldaviensis					115			115	134						
P. vejdovskyi												57			
Quistadrilus multisetosus			38							191					
Spirosperma ferox							96			287		57			
Tubifex tubifex			96	707	77		96	230		287	191				
Immatures															
with capilliform setae		134			230		57			383	96				249
without capilliform setae	536	1,800	326	383	996		402	460	383	2,088	2,356	306			1,015
Naididae: Slavinia appendiculata						19									
Total Number of Organisms	3,255	4,174	1,264	2,258	4,100	19	1,130	3,255	3,083	4,978	3,963	2,010	20	0	3,713
Species Diversity (H')	1.12	1.75	2.41	2.16	2.28	0.00	2.38	2.50	2.67	2.87	1.92	2.04	1.00	0	2.61
Species Richness (S.R.)	0.37	0.60	0.98	0.78	0.72	0.00	1.00	0.99	1.37	1.41	0.85	1.31	0.33	0	1.09
Evenness (J')	0.56	0.68	'0.80	0.77	0.81	0.00	0.79	0.79	0.75	0.78	0.64	0.59	1.00	0	0.79

Water quality did not appear to exert an effect on the presence or absence of benthic invertebrates. At each station, bottom water samples were collected and most of the metals were below the detection limit. Cadmium slightly exceeded the Provincial Water Quality Objective at all stations sampled. Iron and copper exceeded the objective at stations 19 and 21, located inside the harbour's turning basin and channel.

In the 1986 in-place pollutants study conducted by Environment Ontario, detectable levels of PCB, pp-DDE, heptachlorepoxide, endosulphan and hexachlorobenzene were found in sediments at several stations within the harbour and benthic organisms (chironomids and oligochaetes) had detectable levels of all metals. Although the actual significance of tissue residues has not been clearly established, with the exception of Hg and possibly Cd, tissue concentrations of metal were moderate (Appendix 2) and were likely not to represent stressful conditions.

At stations 20, 28, 32 and 395, Hg concentrations in benthic invertebrates approached or exceeded 1.0 ug/g despite the finding that Hg in sediments was well below the provincial guideline for open water disposal. These levels could be of significance with respect to food web transfer of Hg to fish.

Detectable levels of PAHs and pesticides occurred in benthic invertebrates, but the toxicological significance of the observed concentrations is again not clear. Griffiths (1988) has suggested, for example, that PAH concentrations in excess of 54 ug/g in biota represents potentially toxic exposure levels. All biota sampled in the harbour had tissue residues far lower than this guideline. Similarly, pesticide residues were low and are likely to fall below the "no effects level" (Newell et al. 1987).

While measurable levels of metals were detected in sculpins, mercury concentrations were well below 1 ug/g, and tissue residues of other metals were moderate. Some enrichment with Pb and Cr occurred at several sites (Appendix 2). The maximum concentration of PAHs, PCBs, HCB and pp-DDT were 0.25, 0.45, 0.037 and 0.16, respectively. These values are low, compared to results from other locations throughout the Great Lakes.

In 1986, an in-situ mollusc exposure was conducted to assess the spatial extent of the bioavailability of contaminants in the harbour, and laboratory sediment bioassays were used to determine the potential toxicity of contaminants in sediments and whether contaminants were biologically available.

The mussel exposure study indicated that there were few contaminants in the water column that were biologically available to biota. Detectable levels of PCBs (20 ng/g), pp-DDE (3-13 ng/g) and hexachlorobenzene (3.3 ng/g wet weight) were found at some stations; however, the levels were low relative to lakewide values. Metals in mussel tissues were low at all stations (Figure 14).

The sediment bioassays indicated that the sediments were non-toxic to juvenile fathead minnows and mayfly nymphs. Several organochlorine compounds, in particular, PCBs and DDE, were retained by the test species; however, the levels were low and unlikely to affect benthic organisms or to contribute to elevated levels in higher trophic levels of the food chain. Maximum tissue concentrations of PCBs and DDE were 70 ng/g and 48 ng/g wet weight, respectively.

High levels of lead (max = 93 ng/g wet weight) were found in mayflies exposed to sediments from some stations. This was attributed to the sediment bioassessment methodology because lead levels in benthic organisms collected directly from the harbour were not elevated (Appendix 2). It is suspected that the redox potential of the sediments was changed during the preparation of the sediments for the bioassay. Alternately, test species were in contact with contaminated sediments that were buried, to some extent, by clean surficial sediment in the field. If either of these was the case, then resuspension of the sediments through boat traffic or dredging could result in lead becoming biologically available. Further work was conducted in the fall of 1988 to test these hypotheses.

Based on the results for sediment, water and benthic biota, there does not appear to be extensive contamination related to in-place pollutants other than nutrients in Collingwood Harbour. Mercury has been found at elevated levels in some biota despite the fact that the levels in the sediment and water are below the Provincial Guidelines.

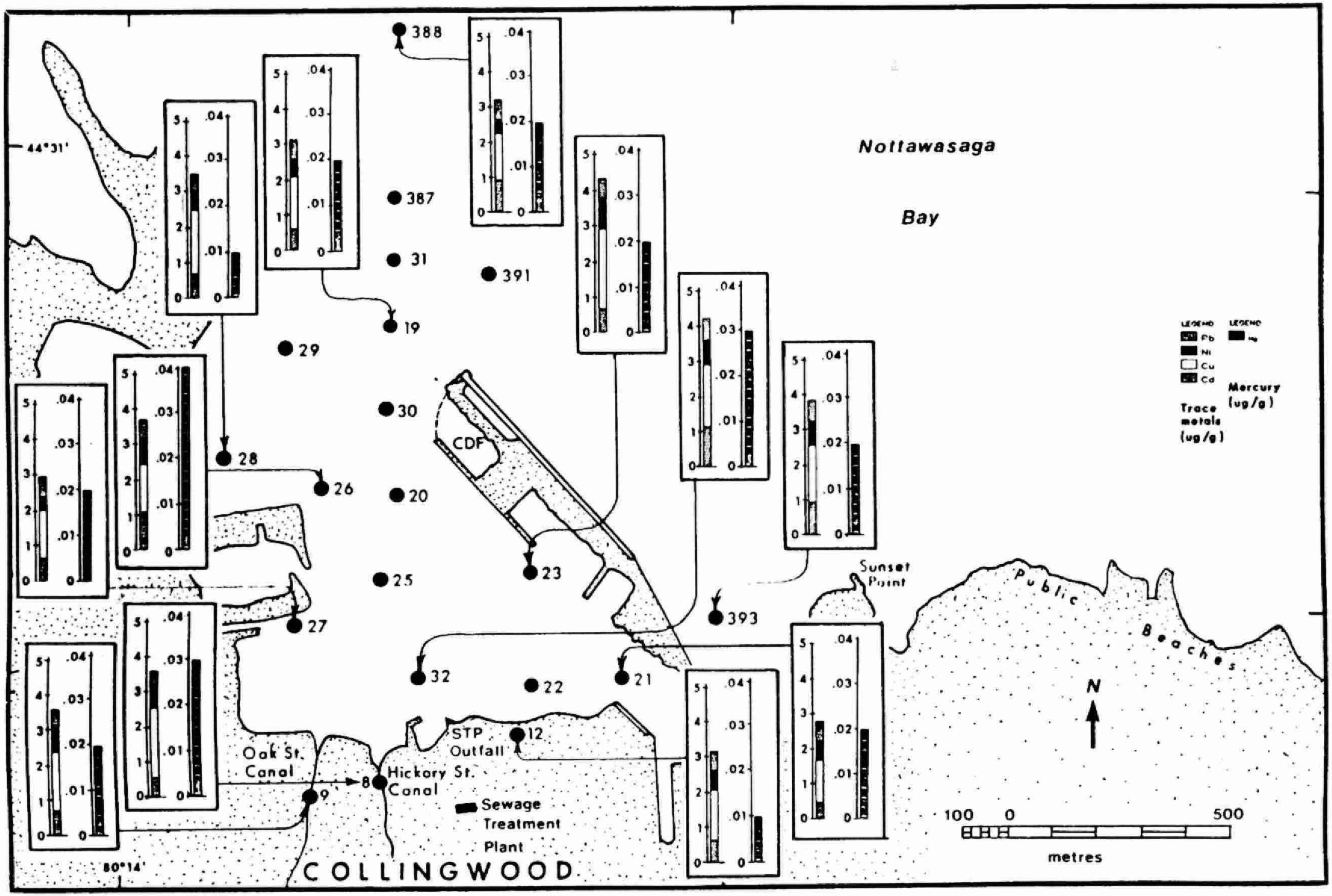


FIGURE 14: Trace metals & mercury in mussels placed in Collingwood Harbour (1986)

At this time, the main concern for Collingwood Harbour sediments in the inner harbour - turning basin involve potential adverse impacts on the biota if buried sediments are resuspended due to shipping operations. If sediments need to be removed for routine maintenance dredging, some material remains unsuitable for open water disposal, based on the sediment chemistry.

Fish:

Although the habitat in the harbour supports warm-water populations such as yellow perch and smallmouth bass, migrant rainbow trout and laketrout backcross enter the harbour from the open waters of Georgian Bay in the spring and fall. Creel surveys carried out by the Ministry of Natural Resources during 1982-85 reveal that anglers seek and catch significant numbers of rainbow trout and laketrout backcross during both spring (April - May) and fall (October - November) months. Yellow perch are fished from the area docks during the open water season and through the ice during winter. About 50 ice huts are set up near the shipyards each winter. Smallmouth bass are known to spawn along the west shore of the harbour, and some summer fishing for these bass is evident. Walleye and rainbow trout regularly sought cover beneath the large ships in the dry dock area of the shipyards and were discovered during "pump-outs".

Fish Habitat:

Fish habitat was identified and mapped for the Collingwood Harbour during August in 1986 when aquatic plant development was maximal (Figure 15). The two major habitat types located in the harbour were rocky rubble areas and submergent or emergent weedbeds. Sites within these two types were sampled in detail (Table 5). A total of ten species of macrophytes (water plants) were identified within these major habitats (Table 6). The dominant macrophyte throughout the nearshore areas in the harbour and the deeper water adjacent to the sewage plant was milfoil. Bulrush was the most abundant species found at the sites just outside the harbour.

Fish Inventory:

The objective of the 1986 inventory was to determine which forage and sport fish species were inhabiting the waters of the Collingwood Harbour. Recognizing that all fishing gear is selective for species and size, four different sampling methods were employed; seine netting, trap netting, gill netting and electro-fishing. The results are listed in Table 7.

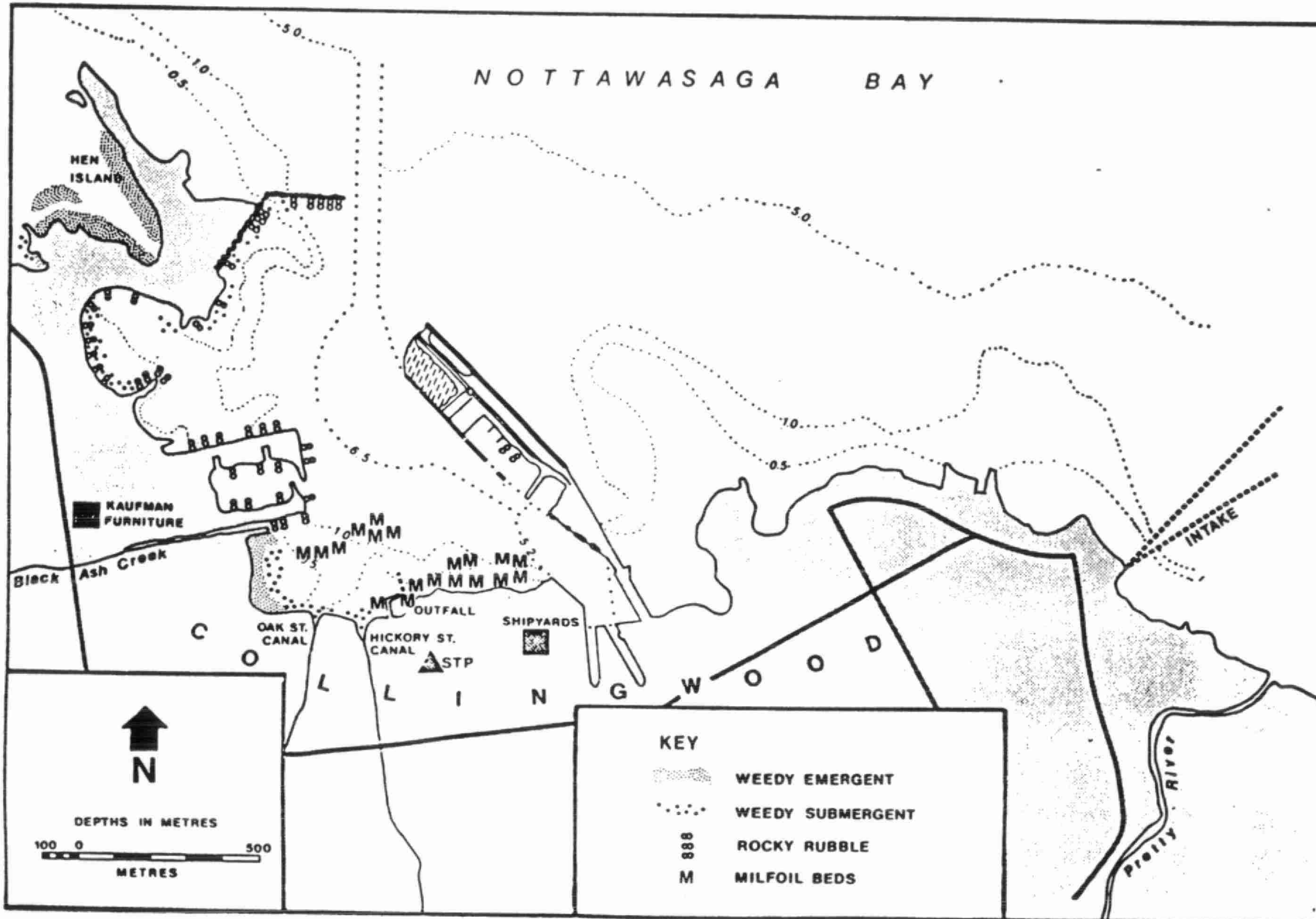


FIGURE 15 MAJOR HABITATS FOUND IN COLLINGWOOD HARBOUR, 1986.

TABLE 5: HABITAT DESCRIPTIONS FOR SEINING SITES IN COLLINGWOOD HARBOUR - AUGUST 1986

Site	Percent of Vegetation Cover	Vegetation Type*			Substrate**					
		Em	Su	Fl	Rub	Sd	St	Mk	Dt	Cl
C1	40	10	90			5	45	10	30	10
C2	55	5	92	3	10	10	20		20	
H1	15		100		45		10			
H2	30		100		20	25	10	25		
H3	30		100		40	15	5	10		
H4	40	48	50	2		30		45	25	
H5	95	15	85					100		
H6	55	50	50					15	5	40
H7	30		100			5	15	10		

* Em = Emergent, Su = Submergent, Fl = Floating
** Rub = Rubble, Sd = Sand, St = Silt, Mk = Muck, Dt = Detritus, Cl = Clay

TABLE 6: SPECIES OF AQUATIC VEGETATION IDENTIFIED FROM COLLINGWOOD HARBOUR DURING AUGUST, 1986

COMMON NAME	SCIENTIFIC NAME
Cattail	*Typha* spp.
Waterweed	*Anacharis canadensis*
Bulrush	*Scirpus* spp.
Lesser Duckweed	*Lemna minor*
Coontail	*Cerataphyllum demersum*
White Water Lily	*Nymphaea* spp.
Water Milfoil	*Myriophyllum spicatum*
Tapegrass	*Vallisneria americana*
Curly Pondweed	*Potomogeton crispus*
Water Smartweed	*Polygonum amphibium*

The harbour fish community in the nearshore areas was clearly dominated by forage fish, primarily bluntnose minnow and alewife. Most of the fish collected were young-of-the-year (YOY), indicating good reproduction. Young-of-the-year yellow perch were utilizing nursery habitat at all sites.

A total of 404 fish were caught using electro-fishing equipment. White sucker (25%) and smelt (19%) were the most abundant species. Sport fish accounted for only 3.8% of the catch. Laketrout backcross represented 1.2% of the total. White and shorthead redhorse suckers and alewife dominated the gillnetting and trapnetting catches. Yellow perch represented 10.8% of the total. Sport fish caught in descending order of abundance included smallmouth bass, walleye, northern pike and lake trout backcross.

Contaminants in Fish:

Twenty yellow perch were collected in 1984 by MNR Huronia District for contaminant analysis. The results indicate low concentrations of mercury, even in large perch (35 cm), and essentially no PCB or Mirex accumulation (Table 8). Additional sport fish such as white sucker, yellow perch and walleye were collected for contaminant analysis during the 1986 field season and the data were incorporated in the 1988 "Guide to Eating Ontario Sport Fish".

In the 1986 harbour collections, yellow perch, walleye (pickerel), and white sucker were collected and analyzed for mercury, PCB, mirex, DDT, chlordane, lindane, aldrin, heptachlor, hexachloro-benzene and octachlorostyrene. These three species were found to meet all Canadian guidelines for unrestricted consumption of fish. Since sampling in 1984 for yellow perch resulted in the collection of larger specimens, a single perch over 35 cm (14 inches) in length and was found to exceed the 0.5 ppm mercury guideline in 1984. While no fish of this size was caught in 1986, the 1988 "Guide to Eating Ontario Sport Fish" still indicates that consumption of yellow perch over 35 cm (14 inches) in length should be restricted.

All sizes of whitefish and Chinook Salmon collected from the Collingwood area were found to meet Canadian Federal guidelines for unrestricted consumption.

TABLE 7: SUMMARY OF FISH INVENTORY FOR COLLINGWOOD HARBOUR, 1986

Species
Alewife
Banded Killifish
Blacknose Dale
Bluntnose Minnow
Bowfin
Brassy Minnow
Brook Stickleback
Brown bullhead
Burbot
Carp
Central Mudminnow
Common Shiner
Emeral Shiner
Gizzard Shad
Greater Redhorse
Johnny Darter
Lake Trout Backcross
Log Perch
Longnose Gar
Mimic Shiner
Moxostoma sp.
Northern Pike
Pumpkinseed
Rainbow Smelt
Rainbow Trout
Rock Bass
Sand Shiner
Shorthead Redhorse
Silver Redhorse
Smallmouth Bass
Spottail shiner
Trout-perch
Walleye
White Bass
White Sucker
Yellow Perch

As part of the MOE spottail shiner 'young-of-the-year' program, a survey was carried out in Collingwood Harbour in the fall of 1985, 1986 and 1987. Emerald shiners were analyzed for organic trace contaminants and metals. PCB residues in both collections were in excess of the IJC Aquatic Guideline of 100 ng/g. Low concentrations of DDT, hexachlorobenzene, chlordane, mercury, lead and cadmium were measured. Mirex, BHC, octachlorostyrene, heptachlor, aldrin, hexachloroethane, hexachlorobutadiene, trichlorotoluene and chlorinated benzenes were not detected.

The results of these surveys show that, with the exception of PCBs, the chlororganic and metal bioavailability to fish in Collingwood Harbour is low. PCB sources to the harbour are limited to non-point inputs from atmospheric deposition, and the possible presence of PCBs in waste oils in the vicinity of the shipyard. PCB inputs may be conveyed by the storm canals or the sewage treatment plant. PCBs were found in fish collected in the vicinity of the Collingwood sewage treatment plant and storm canals discharges. Sediment data, however, do not fully support these locations as active sources. Bottom dwelling organisms did not accumulate PCBs at these sites and PCB distribution in bottom sediments at these locations were not elevated. In addition, due to fish mobility, identifying the precise sources of contaminants is difficult. Table 9 lists sample results for PCBs, DDT, chlordane, mercury, cadmium and lead in fish. It must be noted that the presence of PCBs in fish, while indicative of an active source of PCBs, was not above the consumption guidelines.

TABLE 8

FISH CONTAMINANT DATA FOR YELLOW PERCH SAMPLED FROM COLLINGWOOD HARBOUR, 1984 (N=20) AND 1986 (N=16)

	1986		1984	
Parameter	Mean	Range	Mean	Range
Length (cm)	18.5	14.0-23.9	27.6	24.5-35.2
Weight (g)	89	19 -180	295	200-560
Lipid (%)	1.07*	0.56-1.60	0.70	0.48-0.88
Mercury (ug/g wet wt)	0.06	0.01-0.16	0.20	0.09-0.59
Polychlorinated biphenyls (ng/g wet wt)	74*	ND - 107	ND	ND-25
Mirex (ng/g wet wt)	ND*	ND	ND	ND-ND

note: ND = less than detection limit (= 20 ng/g, 5 ng/g for PCB's and Mirex respectively).
*N = 5

(Environmental Health Bulletin)

TABLE 9: ORGANOCHLORINE AND METAL RESIDUES IN JUVENILE EMERAL SHINERS FROM COLLINGWOOD HARBOUR
(Values in ng/g, wet weight whole fish analyses, ± standard deviation)

Year	No. of Samples Analyzed	Fish Size (mm)	% Lipid	PCB	DDT	Hexachloro-benzene	Chlor-dane	Mercury	Cadmium	Lead
1985	3	82 ± 3	3.0 ± .5	310 ± 55	62 ± 13	4 ± 1	2 ± 1	NA	NA	NA
1986	5	74 ± 4	6.3 ± .3	214 ± 52	51 ± 9	1 ± 1	ND	10 ± 0	64 ± 11	40 ± 7
1987	7	53 ± 4	2.9 ± .3	206 ± 88	43 ± 25	ND	2	ND	NA	NA
Detection Limits				20	1	1	2	10	5	5

ND - Not Detected
NA - Not Available

3. DESCRIPTION OF POTENTIAL SOURCES

Industrial Sources:

A review of industries in Collingwood identified those that could potentially have contributed to the contamination of harbour sediments and water quality enrichment. Table 10 lists industries (locations on Figure 4) with waste streams of relevance to harbour quality, either through contributions to sanitary sewers and/or as a consequence of potential process upsets. In each case, the waste stream of interest, the current treatment scheme, and any relevant past treatment information are documented.

There are no known direct discharges to the harbour from local industrial facilities. Most industries discharged to the sanitary sewer system for treatment at the sewage treatment plant along with other sanitary sewer inputs.

Several large "dry" industries in Collingwood do not have waste streams discharging to the sanitary sewers and were not considered further.

There is still a possibility of process spills from industries to storm sewers that drain to the harbour; however, the possibility of these occurring is very much reduced due to abatement activities in the past few years.

Historically, the operation of Collingwood shipyards may have adversely impacted the harbour sediments, contributing contaminants such as heavy metals and organics. High metal concentrations in sediments may be attributed to the application of paints and scraping of paint from ship hulls. Zinc and zinc chromate coatings are used as primers on ships. These replaced the red lead primer used during the 1950's, 1960's and early 1970's. Other metals such as aluminum, tin, copper and mercury are used in enamels and anti-fouling agents for ships and welding rod bits were disposed of directly to the harbour. The presence of PCBs may be attributed to other historical inputs associated with electrical or hydraulic equipment, but these have not been quantified.

Municipal Point Sources:

The Collingwood Sewage Treatment Plant (STP) was the only identified point source of phosphorus in the harbour, as revealed by the 1980 Ministry survey. Only primary treatment was provided at that time. In 1982, the plant was expanded to include the secondary treatment and phosphorus removal facilities. Under present routine operating procedures, excess sewage is allowed to bypass the treatment process when the plant capacity is reached during major storm events. Table 11 illustrates trends in contaminant loadings from 1980 to 1987 and indicates that by 1986 the plant was still not meeting the provincial phosphorus requirement. The problem was believed to be associated with sludge handling inadequacies which adversely affect effluent quality. The concentration of some heavy metals in the sludge have shown a slight increase while others have stayed the same or had a small decrease (Table 12).

Improvement in the efficiency of the removal of lead, cadmium, copper and total phosphorus by the STP is likely a result of the removal of larger volumes of suspended solids. The decrease in levels of arsenic, chromium, nickel, zinc and the static levels of mercury and total Kjeldahl nitrogen between 1980 and 1983 may be a result of diminished loadings of these substances to the plant from industrial sources.

As a result of the sewage treatment plant being upgraded to secondary treatment, effluent quality improved. Operational inspection studies were completed in September 1985 by MOE and problems were found to be associated with phosphorus removal, primary clarification, sludge thickening, digester operation and insufficient manpower. Operational changes were recommended to the municipality and have been made. Confirming studies were conducted in 1986 and 1987 and demonstrated substantial reductions in P and BOD loadings.

TABLE 10: CURRENT AND HISTORICAL INDUSTRIES IN COLLINGWOOD WITH WASTE STREAMS OF POTENTIAL RELEVANCE TO THE QUALITY OF THE HARBOUR (See Figure 3 for locations)

Company (Product)	Waste Stream of Interest	Current Treatment	Comments
1. Blue Mountain Pottery (pottery, clay ceramics, oven-to-table ware)	.glaze solution high in metals, esp. Pb	.spent glaze—glaze reclaimation →filter-cake(sludge) fired in kiln→ Collingwood Industrial LFS .treated water returned to process .essentially nothing to sanitary sewers	new process started 1985, no discharge to sanitary sewers
2. Collingwood Shipyards (lake & ocean-going ships, dry-dock repairs, hoisting winches)	.shot blast used outside building .pump-out of dry-dock .site runoff .painting	.shot recycled, fines collected inside only .none .dependent on housekeeping and inventory .accumulated scum from spray booths to drums→Collingwood Ind. LFS. - overspray of ships in stocks and fitting out basin to site and basin (2.5% of annual paint used reaches water)	.no longer in operation .sampled Sept. 21/79 - low concentrations of Pb, nutrients in single sample .Pb based primer discontinued 1975 -antifoulant paint only for ocean-going ships - none since 1974
3. Canadian Mist distillers (Canadian Mist Whiskey)	.corn mash - high in BOD & solids, veg. matter .tanks cleaned with caustic wash solutions	.pre-treatment→san.sewers	.only nutrient implications for loadings to STP
4. Goodyear Canada Inc. (commercial hose)	.vulcanizing of hose with Pb .Zn-sterate used in extruder .various solvents	.closed-loop sys. little chance of any discharge to san. or storm sewers .water reprocessed, closed loop sys.	.past discharges to storm sewer leading to Black Ash Creek .reprocess tank overflowed to storm sewer - level indicators and controls installed 1985.
5. Harding Carpets (soft-floor coverings)	.dying (some dyes contain organics)	.pre-treatment with C-filtration→ sanitary sewers	
6. Nacam Products Ltd. - formerly National Starch (food & industrial starches)	.corn. veg. matter .modifying chemicals used in process	.extended aeration pre-trt→san.sewers	.only nutrient implications for loadings to STP
7. The Pottery Studio-Rainbow Ceramics	.glazing solution	.to sanitary sewers	.very small operation

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TABLE 11

COLLINGWOOD SEWAGE TREATMENT PLANT LOADINGS AND CONCENTRATIONS IN EFFLUENT

	1980[1]	1981[2]	1982[3]	1983[4]	1984[5]	1985[6]	1986[7]	1987[8]	1988[9]
Flow (10^3 m^3/d)	15.9	15.9	15.3	17.1	17.4	18.5	17.4	16.1	17.7
Total phosphorus Load (Kg/d)	81	29	9*	20	21	35	26	13	16
Total Phosphorus Concentration (mg/L)	.51	1.82	0.59*	1.17	1.21	1.9	1.5	0.8	0.9
BOD (Kg/d)	1131	1113	229	107	110	107	35	93	101
BOD Concentration (mg/L)	71.1	70.0	15.0	6.3	6.3	5.8	2.0	5.8	5.7
Suspended Solids (Kg/d)	860	668	229	145	148	233	122	205	205
Suspended Solids Concentration (mg/L)	54.1	42.0	15.0	8.5	8.5	12.6	7.0	12.5	11.6

* May not be indicative of the whole year

Requirements are 1 mg/L for Total Phosphorus (17 Kg/d)
25 mg/L for BOD (435 Kg/d)
25 mg/L for Suspended Solids (435 Kg/d)

1980[1] includes values for November and December only.
1981[2] includes values for Feb., Apr., May, July and Nov.
1982[3] includes values for Feb., Apr., May, June, Aug. and Dec.
1983[4] includes values for Jan., Feb., May-Nov. inclusive
1984[5] includes values for Jan., Feb., April, May, June, Sept. and Oct.
1985[6]
1986[7] includes values for June and July
1987[8] annual average
1988[9] annual average

TABLE 12

COLLINGWOOD SEWAGE TREATMENT PLANT SLUDGE RESULTS

Annual Average mg/L

	1980[1]	1981[2]	1982[3]	1983[4]	1984[5]	1987[6]	1988[7]
Arsenic	.33	.33	.18	.17	.14	.18	.21
Cadmium	.10	.14	.17	.13	.21	.09	.11
Chromium	5.63	5.4	2.93	2.52	2.61	2.07	2.67
Copper	20.0	16.5	22.3	21.7	22.0	16.0	16.5
Mercury	.10	.15	.14	.09	.11	.07	.09
Nickel	2.2	1.8	.91	.86	1.08	.41	.35
Lead	31.3	35.	37.7	22.9	42.1	6.0	9.7
Zinc	51.7	51.0	37.3	31.73	36.7	21.1	20.6
T. Kjeldahl Nitrogen	400	511	507	426	416	--	--
T. Phosphorus	1440	2073	1467	1768	1614	1566	1590
% Solids	3.42	2.8	3.12	2.88	3.14	2.91	3.10

1980[1] includes values for November and December only.
1981[2] includes values for Feb., Apr., May, July and Nov.
1982[3] includes values for Feb., Apr., May, June, Aug. and Dec.
1983[4] includes values for Jan., Feb., May-Nov. inclusive
1984[5] includes values for Jan., Feb., April, May, June, Sept. and Oct.
1987[6] annual mean
1988[7] annual mean

Point and Non-Point Sources; Water:

Three small tributaries flow into Collingwood Harbour. The largest, Black Ash Creek, drains local agricultural areas of 11 square kilometres. The two other tributaries known locally as Oak Street Canal and Hickory Street Canal, are intermittent and carry mainly urban stormwater runoff. A number of storm sewers discharge to these tributaries.

In 1986 a dry weather study was carried out to determine the relative inputs to the Collingwood Harbour from these sources. The two canals (Hickory Street and Oak Street), and Black Ash Creek, were monitored as potential sources of contaminants to the harbour. Bacterial levels of fecal coliform, Escherichia coli, fecal streptococci, and Pseudomonas aeruginosa from Black Ash Creek, and the canals (Hickory Street and Oak Street) were low (<150/100 ml, <183/100 ml, and <270/100 ml, respectively) and should, therefore, not have a significant dry weather impact on the harbour. Total phosphorus levels in the canals and creek were sufficiently high (0.02 to 0.07 mg/L) to sustain the excessive plant growth that was observed in these outfalls. However, when dilution in the receiving body is considered, these loadings of total phosphorus may not have a significant impact on the harbour. A preliminary phosphorus budget for the harbour (Figure 16) will be refined to more accurately address the relative significance of point and nonpoint source inputs to the harbour. PCB and metal loadings were variable and their significance relative to other sources must still be quantified. Studies are being developed for 1989 to further refine and ascertain these estimates.

Point and Non-Point Sources; Sediment:

Documented sediment contamination may be a result of past shipyard activities and municipal point and non-point sources. Assessment studies of contaminated sediments in 1986 included benthic community studies, physical and chemical characterization, and laboratory bioassessments. This program provided information relevant to aquatic impacts of the contaminated sediments, and the need to implement corrective measures. Sediments were also sampled in the vicinity of Black Ash Creek, the old Imperial Oil Wharf area, and near the intermittent streams carrying storm and urban runoff.

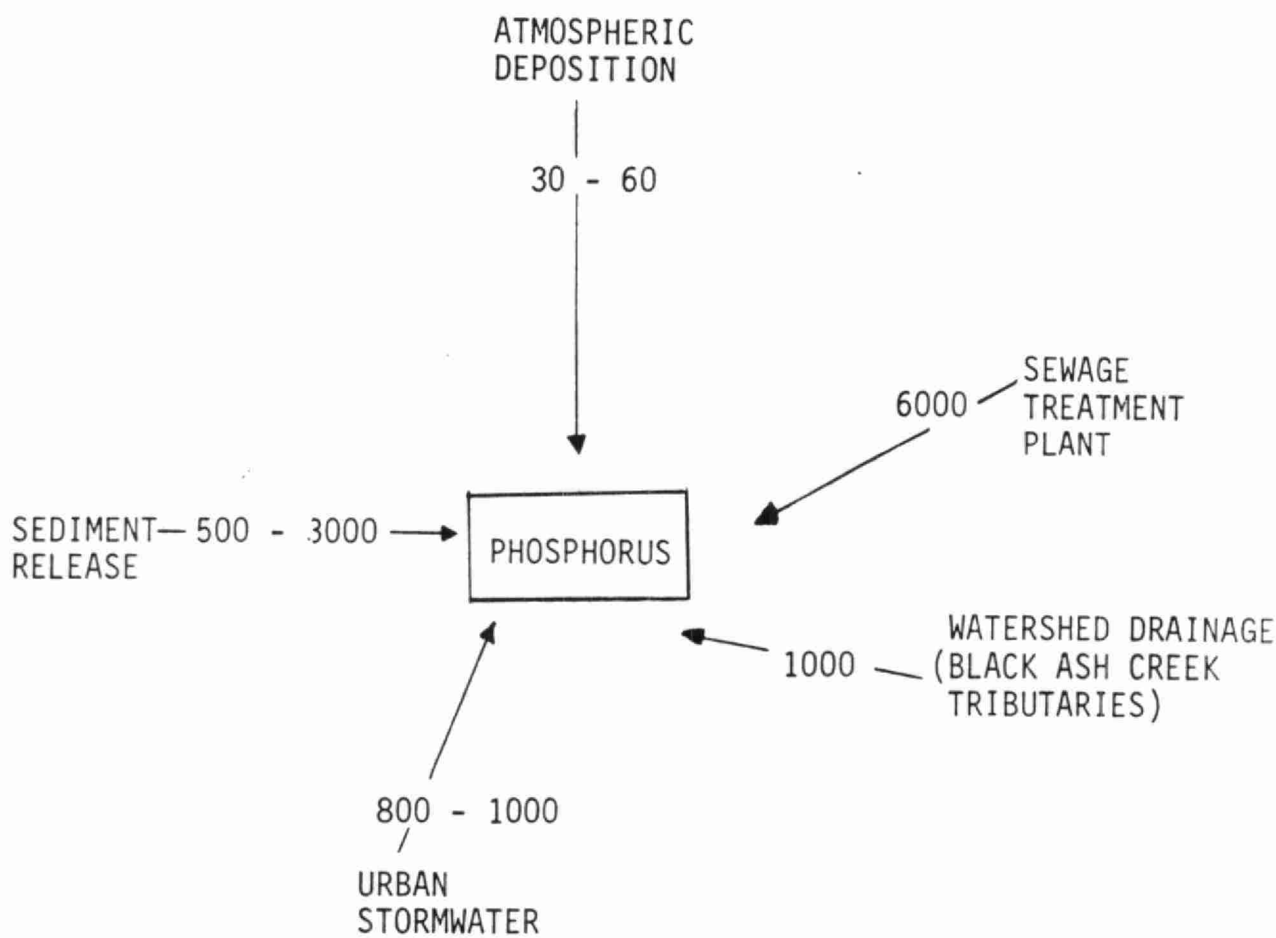
Bottom sediments collected in 1987, following dredging operations in 1986, exceeded the MOE guidelines for open water disposal for substantially fewer sites. Suspended sediments collected at the mouths of the tributaries and the STP showed much higher concentrations of several sediment quality parameters than found in bottom sediments in the harbour, indicating that these suspended sediments are a potential source of contamination to the harbour. This finding also reflects the probable greater percentage of fine-grained and organic material found in suspension. Much of this may not be deposited in the harbour if there is sufficient exchange of harbour waters with those of the Bay. Concentrations of PCBs, nutrients, oil and grease, and metals including copper, chromium, nickel, lead and zinc exceeded the dredging guidelines at several inflows. However, because flows from the tributaries are very low except during storm events and spring runoff, these sources may not represent a major source of contaminated sediments to the harbour.

Overall Contributions of Phosphorus:

The relative loadings of various contaminants from each source has not yet been adequately quantified. However, it is anticipated that the additional studies planned for 1989 will provide the information necessary to determine the relative significance of all sources to harbour water quality in order to evaluate remedial options.

Figure 16 identifies the sources of P to the harbour. The values assigned to the various inputs are, with the exception of the STP, based on a limited set of empirical measurements and are presented primarily for conceptual purposes. In order to adequately assess remedial options, studies scheduled for 1989 will confirm or revise these estimates.

Figure 16. Estimated loadings of phosphorus (kg/yr) to Collingwood Harbour.



4. IDENTIFICATION AND DELINEATION OF SPECIFIC CONCERNS

The surface waters of Ontario are put to many uses, and each use has specific water quality requirements. Quality of a specific receiving water body must therefore be managed to permit the greatest number of uses, based on a concensus of interests of the people who utilize that water body. Collingwood Harbour currently has four primary uses: commercial shipping, non-body contact recreation, fishery habitat and municipal wastewater assimilation.

Based upon available data, concerns have been raised respecting potential deleterious impacts of contaminants in water and sediment on each of these uses.

a) Commercial Shipping

Periodic dredging within Collingwood Harbour is essential to maintain commercial shipping activities. Most recent data on sediment quality, however, indicates sufficient contamination to require a continuation of confined disposal for the dredged material. If the sediment quality could be improved such that it meets the MOE criteria for open water disposal, costs of dredging could be greatly reduced.

b) Non-Body Contact Recreation

Pleasure boating and sport fishing are the principal non-body contact recreation activities pursued within the harbour. Environmental concerns with respect to pleasure boating relate to the adverse effects of algae and turbidity on the water's aesthetic quality. Algal growth is thought to be governed by phosphorus levels in the water, while high turbidity is a result of excessive suspended algae and inorganic matter. Additional concern surrounds preliminary data that suggest bacterial densities at the STP outfall are occasionally elevated. Although bacterial densities in the receiving body are generally low as a consequence of effluent dilution, several samples still exceeded the Ministry objectives for body contact recreation in 1986 and an extensive bacteriological survey will be conducted in 1989 to determine the spatial and temporal patterns of bacterial densities in the harbour.

c) Sport Fish and Fishery Habitat

A potential concern with respect to sport fishing is that of chemical contamination of sport fish. This would necessitate restrictions on consumption. However, except for low concentrations of mercury in large perch, no contamination has been identified.

There may be adverse impacts from contaminated sediments on aquatic biota and benthic organisms within the harbour. However, studies to date strongly suggest no such impacts. Further stresses may be caused by the effects of siltation.

d) Municipal Wastewater Assimilation

The Town of Collingwood's sewage treatment plant discharges effluent to Collingwood Harbour. The assimilative capacity of the receiving water influences the degree of wastewater treatment required.

Water quality in the harbour is also affected by the degree of exchange between the harbour and Nottawasaga Bay. Consequently, no activities are to be permitted that would restrict exchange with the open water and dredging of the harbour mouth must be continued as necessary. Development of a budget of Collingwood Harbour water quality parameters are underway to identify whether the current level of sewage treatment is adequate for the prevention of nuisance algal growth.

An additional concern relates to bacterial contamination within the harbour. Data generated in 1986 indicated that bacteria levels were occasionally in excess of those recommended for swimming and bathing at some stations. Although these recreational activities are not currently encouraged in the harbour, demand for this use in specific areas of the harbour is possible in the future. Consequently, surveys are being planned for 1989 that will identify source loadings and receiving water conditions through both dry and wet weather periods.

II DEFINITION OF SPECIFIC GOALS AND OBJECTIVES OF REMEDIAL PROGRAMS

The surface waters of Ontario are put to many uses, and each use has specific water quality requirements. Water quality must be managed, preserved, and restored where necessary to permit the greatest number of uses, based on the best interests of the people of Ontario.

The Province has agreed that the revised Specific Water Quality Objectives contained in the Great Lakes Water Quality Agreement shall be used in environmental programs to achieve and maintain Great Lakes water quality.

GOAL: To ensure that the surface waters of the province are of a quality which is satisfactory for aquatic life and recreation.

Water which meets the water quality criteria for aquatic life and recreation (designated as the Provincial Water Quality Objectives), will be suitable for most other beneficial uses, such as drinking water and agriculture. For the few parameters where better water quality is required to protect these other beneficial uses in a given location, the appropriate criteria shall be applied for that location.

POLICIES:

Areas with Water Quality Better than the Objectives

In areas which have water quality better than the Provincial Water Quality Objectives, water quality shall be maintained at or above the Objectives.

Areas with Water Quality Not Meeting the Objectives

Water quality which presently does not meet the Provincial Water Quality Objectives shall not be degraded further and all practical measures shall be taken to upgrade the water quality to the Objectives.

The waters of Collingwood Harbour have on occasion, exceeded the Provincial Water Quality Objectives for some specific uses such as body contact recreation. Certain areas of the harbour also did not meet the provincial guidelines for the prevention of nuisance algal growth and for the open water disposal of dredged sediments.

Historical impacts of ship construction, current shipping activities in the harbour, treated wastewater inputs from the municipal sewage plant, and land drainage, are considered to limit the full use of the harbour.

An objective of the anticipated public consultations will be to identify the more "sensitive uses". These may require improvements in water quality to meet the identified use goals. Areas that may require special attention will likely be associated with those shorelines proposed for more intensive residential and possibly further recreational development, and areas to be further identified by the Ministry of Natural Resource as being conducive to the promotion of the local fishery.

III DESCRIPTION OF REMEDIAL ACTION

1. APPLICABLE REGULATORY AND ADMINISTRATIVE TOOLS

The Province employs water quality objectives of the Great Lakes Water Quality Agreement for the protection of aquatic life and recreation and supplements these with stated provincial objectives and guidelines where required to address parameters of concern in Collingwood Harbour.

Certificates of Approval issued under the Environmental Protection Act to municipalities and industries outline effluent requirements and frequency of effluent sampling to ensure reliable information on pollutant discharges.

The Ministry of the Environment conducts local industrial and municipal inspections to determine whether discharges are in compliance with Certificates of Approval.

2. STATUS OF REMEDIAL ACTION

Sediment

° Until rendered acceptable for open-water disposal, contaminated dredged sediment is disposed of in a confined area to prevent widespread degradation to the greater harbour ecosystem. The harbour's turning basin was dredged in 1986 and the dredged sediments were placed in a confined disposal facility (CDF) built into the northern portion of the grain elevator pier. When completely filled and stabilized, the CDF will be capped to prevent leaching. The 1986 sediment and biota study results indicate that, although biota are accumulating mercury and perhaps Pb and Cd, the overall contaminant levels are on the decrease. By 1987, the surficial sediment in most areas of the harbour met the MOE guidelines for open water disposal for most contaminants.

Municipal Sewage Treatment Plant

- As a result of ongoing operational problems, primarily related to in-plant sludge handling which adversely affects effluent quality, assessments are being made of current plant design and operations for the development of additional functional improvements. Specific investigations and recommendations aimed at improved sludge handling and general plant operation to bring effluent phosphorus into compliance, as well as to provide a general improvement in effluent quality, were implemented in 1986. The Collingwood STP underwent a three-phase investigation. Phase 1 of the study program involved an in-depth review of historical plant performance data. The Collingwood STP had made operational changes to correct chemical dosage inadequacies subsequent to the Phase 2 investigations. Phase 2 of the study program involved field evaluations to establish the critical factors affecting phosphorus removal performance. Phase 3 involved extended monitoring of plant performance and optimization of operating conditions to document the success of these operational changes. Phase 3 of the study program was intended to demonstrate that phosphorus removal performance improvements could be achieved in a cost-effective manner in most cases by low capital cost measures.

  Major industries in the Town of Collingwood were identified as major contributors to the treatment facility - a starch plant and a distillery. These industries were also identified as major sources of phosphorus, based on town sewer monitoring programs: the starch plant during production of phosphorylated starches and the glass plant from glass washing operations. A significant fraction of the STP phosphorus loading was attributable to these sources. In the late fall of 1986, the two large industrial contributors began to initiate in-house steps to reduce phosphorus discharges to the sanitary sewer at the direction of the Town of Collingwood and LOF Glass implemented process changes which eliminated phosphorus discharge to the STP.

  As Town staff had already initiated measures to reduce the influent phosphorus concentrations to more typical levels, a Phase 3 monitoring program was initiated to optimize chemical dosage and document that an effluent total phosphorus concentration of less than 1 mg/L could be achieved on a consistent basis.

Results of Phase 2 and Phase 3 raw sewage samplings are compared in Table 13 in terms of concentrations of total and filtered phosphorus, suspended solids and BOD_5. Waste strength, in terms of all parameters, was lower during the Phase 3 program than during the Phase 2 program. The average daily flow during Phase 3 was 16,500 m^3/d, compared to 17,440 m^3/d during Phase 2. Dilution due to rainfall and spring runoff during Phase 3 does not appear to be a significant contributor to the reduction in sewage strength as flows during the two sampling periods were comparable. The in-plant measures instituted by the large industrial contributors to reduce phosphorus discharges may have also reduced discharges of BOD_5 and suspended solids. The industrial phosphorus discharge control program had a marked effect on influent phosphorus concentrations at the plant. The concentration measured during Phase 3 was only 36 percent of that experienced during the Phase 2 monitoring period.

Final effluent quality during Phase 3 is presented in Table 13. Effluent BOD_5 was consistently less than 25 mg/L and average approximately 5 mg/L. Final effluent suspended solids were high compared to historical data, averaging 16.6 mg/L. The high average TSS concentration relates to two plant upsets, which occurred on March 2 and March 31. The average final effluent total phosphorus concentration was less than 0.50 mg/L over the Phase 3 monitoring period despite the upset event on March 31 when the total phosphorus concentration was 3.8 mg/L due to the suspended solids carryover.

The average alum dosage during this monitoring period was 7.4 mg/L Al, comparable to the estimated dosage of 8 mg/L during Phase 2. However, the molar metal to soluble phosphorus dosage (Al:P) ratio averaged 4.23 during Phase 3 compared to 0.94 during Phase 2 as a result of the dramatic reduction in influent phosphorus loading. Under these dosage conditions, virtually complete precipitation of phosphorus was achieved. The soluble phosphorus concentration in the final effluent never exceeded the analytical method detection limit (typically 0.3 mg/L for the sample volume available).

TABLE 13 COMPARISON OF RAW SEWAGE QUALITY DURING PHASE 2 AND PHASE 3 MONITORING AT COLLINGWOOD WPCP, 1986 AND 1987

	BOD_5 (mg/L)	TSS (mg/L)	PHOSPHORUS (mg/L)	
			TOTAL	SOLUBLE
Phase 2 *	145	178	13.7	10.6
Phase 3 **	120	106	4.9	3.3

* Based on 11 sampling days between June 18 and July 15, 1986.

** Based on sampling period between February 1 and March 31, 1987 (BOD_5 - 20 samples; TSS - 36 samples; phosphorus - 11 samples).

Non-Point Sources Including Land Drainage

o No quantitative data currently exist on the potential contribution of contaminants to the harbour from shipyard runoff. The use of red lead ship primer was discontinued in the early 1970's. A brief study of shipyard runoff was conducted in 1986.

Samples of standing and running waters in the dry dock and bottom sediments were analyzed for metals, nutrients and PCBs. Exceedingly high concentrations of Cu, Pb, Cr and Zn were detected in sediments (8500, 2700, 260, 34800 ug/g, respectively). Cadmium concentrations (4 ug/g) were also higher than MOE dredging guidelines. These metals also exceeded PWQO's in water samples. Further study focussed on the shipyard will be required to quantify its potential impact on the harbour in light of proposed development on the site.

o No quantitative data currently exist on the potential contribution of contaminants to the harbour from stormwater drainage. Black Ash Creek and two intermittent creeks carry mainly urban stormwater runoff and are not considered to be of major significance during periods of low flow.

Land drainage and storm sewer runoff was assessed in 1986 through studies on Black Ash Creek drainage into the harbour. A wet weather survey is necessary to quantify the contaminant loading to the harbour from these inflows.

3. INTERIM ACTION OF 1986-87

° Table 14 summarizes Collingwood Harbour Environmental Concerns and outlines the 1986-87 studies in response to those concerns. Table 15 outlines the 1986-87 fieldwork programs, the results of which have been incorporated into this document. These include:

- water quality investigations, including nutrients and bacteria, algal biomass and productivity
- STP effluent characterization
- contaminated sediment investigations (toxicity and bioavailability)
- benthic macroinvertebrate community structure analysis and analysis for contaminants in tissues
- investigation of Black Ash Creek, storm sewers and shipyard runoff.
- evaluation and inventory of fish habitat
- sport fish collections examining contaminants in fish biomonitoring - analysis for contaminants uptake
- current metering to define physical exchange with Nottawasaga Bay.

° The 1988-1989 fieldwork plans are also included in Table 15.

° A federal-provincial Technical Working Group on Contaminated Sediments has been formed for the specific purpose of providing coordinated scientific research on the significance of contaminated sediments, and technical advice on remedial measures in Areas of Concern. Collingwood Harbour was addressed specifically in 1986. Where necessary, specific measures such as removal, treatment, isolation or disposal of these sediments will be assessed and incorporated in the Remedial Action Plan.

TABLE 14 - SUMMARY OF ENVIRONMENTAL CONCERNS IN COLLINGWOOD HARBOUR

CONCERN	PAST AND PRESENT ACTION	COMPLETED PLANS AND STUDIES
Nuisance Algae (identified 1979). Total phosphorus levels in harbour above PWQG Bacterial contamination.	Collingwood STP expanded to provide activated sludge and secondary treatment with phosphorus removal (1982). Following an MOE investigation of the STP in Sept./85, several in-plant recommendations were made to improve phosphorus reduction and general operations.	1986-87 Studies: . investigated water quality including nutrient and bacterial levels; . include STP effluent characterization; . examined nuisance algal growth and contaminants therein.
Surficial sediment contamination - PCB's, lead and zinc (1974, 1983) exceeded Provincial guidelines for open-water disposal of dredged sediment.	New CDF for contaminated dredged sediment presently being constructed to replace old CDF (Figure 3 for location). The harbour entrance, the shipyard area was dredged during the fall of 1985. Dredged materials from the entrance channel were disposed of in the open lake (Nottawasaga Bay) and dredged spoils from the shipyards were disposed of on land. Additional dredging of the turning basin and shipping channel in the harbour was completed late summer 1986. Dredged sediments were placed in the newly built CDF.	1986-87 Studies: . assessed in-place pollutants including their toxicity and bioavailability, both before and after dredging; . determined the macroinvertebrate community structure by species numeration and analyze for possible contaminants in those benthic organisms found; . investigated heavy metals, PCB's and pesticides in surface water as well as off bottom;
Lack of information on: additional contributors (i.e. loadings of pollutants that enter the harbour from point and non-point sources). Possible impingement on Nottawasaga Bay.		1986-1987 Studies: . investigated Black Ash Creek and storm sewer outflow; . included some physical measurements to assess the exchange between the harbour and Nottawasaga Bay; . determined quality of shipyard runoff and its impact on both sediment and water quality.
Fishery Habitat	Past MNR-MOE sport fish program carried out in Collingwood Harbour (only yellow perch data) as well as in nearby streams and Nottawasaga Bay.	Potential for Fishery Habitat Assessment (MNR) and examination of contaminant levels of other species including "young-of-the-year".
Bioaccumulation of contaminants by fish	1985 program carried out in October provided inconclusive due to an inadequate quantity caught for analyses.	Spottail young-of-the-year program completed for the 1986 field season.

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4. ADDITIONAL PLANS AND STUDIES

In order to further update information on harbour quality, the following activities are scheduled for 1988/89:

- refining estimates of nutrient and contaminant loading to Collingwood Harbour through a wet weather survey at all inflows;
- reassessing the significance of sediment contamination to the biota through laboratory sediment bioassays;
- conducting an intensive bacteriological survey to verify the results of 1980, 1983 and 1986;
- proceeding with phase two of the Public Involvement Program. This involved assembling a Public Advisory Committee to obtain consensus on the desired use options for the harbour. The first meeting was held on November 25, 1988.

5. TENTATIVE LONG-TERM MONITORING PLAN

Studies of Collingwood Harbour were carried out during 1986-87 to assess the effectiveness of upgrading the STP and dredging operations. The Remedial Action Plan's environmental data base will then be finalized based on information from these surveys and additional data acquired in 1989. Long-term monitoring will also be identified and is likely to include:

Water:	limnological studies performed every 5 years;
Sediments:	a detailed sediment survey performed every 5 years; site-specific work as needed;
Biology:	algae sampled every 5 years, benthos sampled every 5 to 10 years;
Spottail Shiners:	where possible, sufficient populations of spottail shiners will be collected every 5 years and analyzed to determine trends in known contaminants.

The final details of the monitoring program will evolve to meet the needs of the completed Remedial Action Plan.

TABLE 15: COLLINGWOOD HARBOUR RAP FIELD STUDIES

PROJECT	RESPONSIBLE GROUP AND CONTACT	FIELD WORK COMPLETED	LAB RESULTS	REPORT DRAFT	FINAL DRAFT
Centrifuging S.S.	GLS - K. Simpson	Mar. 31, 1986	Feb. 1987	April 1987	Summer 1987
Surficial Sediment	GLS - K. Simpson	Oct. 1986	Mar. 1987	April 1987	" "
Water Quality	GLS - K. Simpson	Nov. 14, 1986	Feb. 27, 1987	April 1987	" "
*Water Quality	GLS - G. Krantzberg " M. D'Andrea	Nov. 1989	Mar. 1990	May 1990	
Exchange Studies (drogue tracking)	GLS - B. Kohli GLS - K. Simpson	Nov. 1986	Nov. 1986	Feb. 6, 1987	" "
Tributary	WWM - S. Harangozo	July, 1987		Winter 1988	
STP Monitoring	WWM - R. MacLean	Dec. 1986	Jan. 1987	Feb. 20, 1987	" "
Shipyards - Soils	WWM - R. MacLean	Sept. 1986	Mid Dec. 1986	Feb. 20, 1987	" "
Shipyards - Drydock	WWM - R. MacLean	Aug. 1986	Mid Dec. 1986	Feb. 20, 1987	" "
Dry Weather	WWM - R. MacLean	Sept. 1986	Mid Dec. 1986	Feb. 20, 1987	" "
Cladophora	ABS - M. Jackson	July, 1986	Summer'87 - Metals Fall'87 - Organics	Late Winter 1988	January 1988
Algae Bioassay	ABS - L. Heinstch ABS - K. Nicholls	Oct. 1986	Feb. 1987	Mar. 25, 1987	
Fish Habitat Evaluation	MNR - A. Smith	Sept. 1986	Jan. 1987	Feb. 1987	Summer 1987
Wetland Evaluation	MNR - A. Smith	Sept. 1986	Jan. 1987	Feb. 1987	" "
Fish Community Composition	MNR - A. Smith	Sept. 1986	Nov. 1986	Feb. 1987	" "
Sport Fish Contam.	ABS - A. Johnson	Sept. 1986	Late Summer - Hg Late Fall - PCBs	Dec. 1987	January 1988
Juvenile Fish (YOY)	ABS - K. Suns	Oct. 1987	Early Summer '88	Sept. 1988	Oct. 1988
In-Place: Chemi. frac	ABS - D. Persaud	July 1986	Feb. 1987	April 1987	Summer 1987
Surficial Sediment	ABS - D. Persaud	July 1986	Feb. 1987	April 1987	" "
Sediment bioassay	ABS - A. Hayton	July 1986	Mar. 1987	April 1987	" "
bottom water quality	ABS - D. Persaud	July 1986	Feb. 1987	April 1987	" "
Class	ABS - A. Hayton	May 1986	Apr. 1987	May 1987	" "
Benthic Enumeration	ABS - D. Persaud	July 1986	Feb. 1987	March 1987	" "
Benthic Tissue	ABS - D. Persaud	July 1986	Feb. 1987	April 1987	" "
Sculpins Tissue	ABS - D. Persaud	July 1986	Feb. 1987	April 1987	" "
Phosphorus Frac	ABS-EPS - L. Sarazin	July 15, 1986	Jan. 28, 1987		" "
Coring	ABS-EPS - L. Sarazin	July 15, 1986	- Organics		" "
*Coring	GLS - G. Krantzberg	Oct. 1988	Feb. 1989	April 1989	Summer 1989
*Sediment Bioassay	ABS - T. Lomas	Oct. 1988	Mar. 1989	May 1989	Summer 1989

* Projects planned for 1988/89

GLS - Great Lakes Section, Ministry of the Environment (MOE)
WWM - Waste Water Management, (MOE)
ABS - Aquatic Biology Section, (MOE)
MNR - Fish and Wildlife, Ministry of Natural Resources
EP - Environmental Protection, Environment Canada

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IV PUBLIC INVOLVEMENT PROGRAM

The intent of the public involvement program is to provide the Town of Collingwood, as well as Simcoe County and other interested parties with an opportunity to comment on, and provide input to the preparation of the final Remedial Action Plan prepared for Collingwood Harbour. The information feedback program will:

- confirm or deny some of the assumptions contained in the draft RAP;
- identify and possibly lead to the resolution of conflicting uses of the study area;
- identify any concerns relating to environmental quality; and
- identify any future desired plans for the study area.

The Collingwood Harbour public consultation program is divided into four major phases:

Phase 1 of the public consultation program is to inform and educate the public regarding the RAP process and the current status of the aquatic environment within the area of concern. To accomplish this, a newsletter outlining the current environmental status of Collingwood Harbour and the public consultation program was published, subsequent to which a public meeting/open house was held. The local news media was kept informed of the RAP's development through discussions with RAP personnel. This stage of the public consultation program began in December 1987 and was completed by September 1988.

Phase I of Collingwood Harbour's Public Involvement Program involved all local media to inform the public about the RAP: newspaper, radio, community television. The Collingwood populace was made aware that a remedial action plan is required for the harbour; that the present environmental condition of the harbour is generally encouraging, and that the public will have an opportunity for input into the plan. Major stakeholders indicated an interest to participate in the RAP. The Town offered its assistance. Despite some problems with reaching local residents with the first issue of the newsletter, the public forum was well attended.

The RAP team now has at its disposal a mailing list of stakeholders, interested residents and media contacts. Many of the stakeholders attended the public meeting and have met members of the RAP team.

Impressions gathered from discussions with stakeholders, comments collected at the public forum, and a review of the questions and answers from the public forum, all provided the RAP team with a preliminary understanding of public aspirations for the RAP. These can be broadly categorized into three areas, but are not meant to imply concensus or that decisions have been made on these issues.

Concerns

- No further water quality deterioration should be allowed;
- The water quality should be improved;
- An action plan detailing the clean-up should be prepared;
- As long as Collingwood has industry it will have pollution, and this may not be acceptable;
- Industry is a mainstay of Collingwood and the RAP must take industry's contribution to the Town into account;
- The RAP should work to get Collingwood Harbour off the Area of Concern list.

Objectives for the Harbour

- The harbour should be a haven for recreation;
- Harbour wildlife should be protected;
- Industry using the harbour should be clean industry;
- Boating including canoeing and sailing should be available;
- The water should be sufficiently clean that accidental exposure would not pose a serious threat from a human health standpoint;
- The harbour should support a healthy fishery;
- The harbour should/should not support swimming;
- The harbour waters should/should not ultimately be drinkable.

It appears that consensus exists on many of the issues. However, the degree of improvement and the beneficial uses that require restoration will require focusing. Future stages of the RAP Public Involvement Program should accomplish these tasks.

Phase 2 is designed to obtain the views and priorities of the public with respect to desired use goals, including the level of water quality necessary to achieve these goals. This component of the public consultation program began in November 1988. Once the use goals have been identified, remedial options for their achievement will be developed by the RAP team.

Phase 3 of the process is used to obtain input and feedback, from the public, on the remedial options for achieving the use goals. The remedial options and their implications (such as timetables, costs, benefits), will be presented to the involved public, since an understanding of what will be required to achieve certain uses may result in changes in use goals and their priority. The agreed upon use goals and remedial actions required to achieve them will be incorporated into the RAP.

Phase 4 of the public consultation program is a public review of the RAP report, into which the use goals and required remedial actions have been incorporated. Opportunities will be provided for the public to review the report and provide comments, in order to ensure that it accurately reflects their views. This stage of the process may be repeated several times, as changes are made to the remedial options and use goals as a result of the public's comments.

REMEDIAL ACTION PLAN - TIMETABLE

ACTIVITY	INITIATION DATE
Phase I, Public Involvement Program	July 1987 (completed)
Identification of Use Goals	November 1988
Preferred Remedial Options	January 1989
Draft RAP (II) for Review	July 1989
Final Collingwood RAP for Review	January 1990
Submission of RAP to IJC for Water Quality Board	July 1990

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APPENDIX I

DETAILED LISTING OF NUTRIENTS AND CONTAMINANTS

IN SEDIMENTS (1974-1986) AND SUSPENDED

SEDIMENTS (1986) FOR COLLINGWOOD HARBOUR

IA

MEAN CONCENTRATIONS[1] OF METALS, ORGANIC COMPOUNDS AND NUTRIENTS IN COLLINGWOOD HARBOUR SEDIMENTS, 1974, 1983 AND 1986

Station	Year	PCBs	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn	Fe	Al	Total Kjeldahl Nitrogen	Total P	Oil and Grease	Total Organic Carbon	Sand (Psize1)	Silt (Psize2)	Clay (Psize3)
3*	1986	263	6.7	1.87	55.4	159	0.75	10.9	122	238	5,340	50,450	26.2	36.7	22,000	231	-	-	-
13*	1986	20.6	5.7	1.28	36.3	64	0.06	21.4	110	157	22,860	13,830	5.7	1.86	1,300	57	-	-	-
14*	1986	37.5	19.4	1.4	822	118.5	0.27	417	130	980	31,500	22,000	5.6	2.80	2,900	59	-	-	-
15*	1986	66.7	28.1	2.1	55	153.3	0.09	27.7	387	7.20	20,333	14,000	3.3	1.9	-	53.3	-	-	-
19	1974	800•	-	3.92•	24.5	37.2•	0.08	33.3•	35.8	99.1	-	-	-	-	-	-	-	-	-
	1983	80•	2.61	0.4	22	23	0.05	13	38	69	19,000•	12,000	2.0	1.8•	-	-	-	-	-
	1986	66•	-	0.46	22.3	25.3•	0.068	12.3	34	53.3	11,025•	6,650	1.1	0.96	1,093	20.3	0.6	43.2	55.9
20	1974	860•	-	4.20•	26.3•	464•	0.17	32.4•	127•	123•	-	-	-	-	-	-	-	-	-
	1983	100•	3.79	0.68	31•	44•	0.11	18	80•	130•	16,000•	8,400	1.5	1.4	-	-	-	-	-
	1986	65•	-	0.64	29.5•	40.5•	0.12	16.8	57.8•	96.8	13,500•	9,150	1.9	1.68•	2,875•	30.3	2.0	24.0	79.3
21	1974	900•	-	4.46•	23.8	50.6•	0.19	28.3•	214•	127•	-	-	-	-	-	-	-	-	-
	1983	170•	3.84	0.6	37•	52•	0.15	18	120•	180•	4,500	3,500	0.3	0.5	-	-	-	-	-
	1986	192•	-	13.5•	36.3•	72.3•	0.24	18.5	133•	195•	17,000•	10,325	2.2	2.3•	3,175•	27.8	0.2	13.4	86.4
22	1983	55•	3.38	0.4	25	31•	0.08	14	80•	94	5,200	3,400	0.4	0.3	-	-	-	-	-
	1986	55•	-	0.33	18	25.5•	0.11	8.5	47.5	69	9,300	5,250	1.2	1.51•	2,370•	16	0.1	69.5	30.5
23	1983	30	3.61	0.65	31•	46•	0.15	17	100•	150•	14,000•	8,900	1.5	1.0	-	-	-	-	-
	1986	102.5•	-	0.62	28•	49•	0.23	16	79•	115•	15,000•	9,200	2.1•	2.67•	4,700•	30	0.1	25.0	74.9
25	1983	95•	3.66	0.40	21	59•	0.12	11	38	65	21,000•	12,000	2.6•	1.9•	-	-	-	-	-
	1986	40	-	0.42	18.2	25.4•	0.12	9.65	34	51.2	10,200•	6,250	1.3	1.2•	2,450	15	2.0	50.6	47.4
28	1986	32.5	-	0.38	17	21.5	0.09	9.7	25	46	9,150	5,600	1.6	0.83	2,250	16.5	0.2	56.5	43.3
30	1986	92.5•	-	0.61	27	43•	0.14	17.5	56•	94	15,500•	9,750	2.0	1.63•	2,018•	27	0.5	34.5	64.9
32	1983	50	0.98	0.2	7.5	9.0	0.05	5.2	18	37	8,900	5,400	0.7	0.5	-	-	-	-	-
	1986	22	-	0.22	14	6.8	0.03	3.5	9.6	19	7,150	3,300	0.4	0.58	934	5.6	0.2	90.4	9.4
387	1983	20	1.9	0.4	7.5	9.1	0.01	9	6.5	24	14,000•	9,100	0.9	1.0	-	-	-	-	-
	1986	20	-	0.29	18	18.5	0.02	10.5	10.5	26	10,350•	6,000	0.95	0.60	2,612•	13	0.1	63.4	36.5
388	1983	20	1.34	0.3	12	5	0.01	4.8	2.8	9.3	18,000•	11,000	1.6	1.5•	-	-	-	-	-
	1986	20	-	0.26	14.7	8.7	0.03	5.6	5.2	9.7	21,240•	3,400	0.56	0.40	569	10.6	4.4	51.8	43.8
391	1986	20	-	0.22	17.5	9.6	0.06	3.9	18.5	10.4	6,800	3,450	0.25	0.34	1,497	5.25	0	0	100
393	1986	20	-	0.32	10.9	11	0.06	4.3	13.5	31	6,450	3,800	0.8	0.47	1,468	10	0.2	83.4	16.4
394	1986	20	-	0.23	14.5	7.6	0.04	4.2	5.0	9.0	8,500	3,950	0.3	0.41	794	5.5	5.9	75.2	18.9
MOE Dredging Guideline		50	8	1.0	25	25	0.3	25	50	100	10,000	-	2.0	1.0	1,500	-	-	-	-

[1] µg/g for metals and oil and grease, ng/g for PCBs, and mg/g for TKN, total P and TOC, particle size fractions in %. Concentrations reported below detection limits reported at limits of detection.

* Suspended sediments from point source stations.

• Dredging guideline exceeded.

IB

CONCENTRATIONS[1] OF METALS AND ORGANIC COMPOUNDS IN SUSPENDED SEDIMENTS FROM POINT SOURCE STATIONS[2] AT COLLINGWOOD HARBOUR, 1986 (Reported mean values with standard deviations in parentheses for months where more than one sample collected)

	Station 3					Station 13					Station 14		Station 15
	Mar	May	Jul*	Sep	Oct	Mar*	May	July	Sep	Oct	Mar	Sep	Mar*
Al	42,000	45,000	63,500 (707.1)	38,000	73,000	16,000 (4,243)	-	9,800	19,000	12,000	23,000	21,000	14,000 (1,000)
As	-	5.26	-	-	6.1	4.89 (1.22)	-	-	-	-	19.4	-	28.1 (27.6)
Cd	0.61	0.35	1.6 (0.0)	4.5	2.3	0.23 (0.01)	-	2.0	3.3	2.2	1.3	1.5	2.1 (0.89)
Cr	48	41	61.5 (2.12)	48	57	37 (9.9)	-	38	40	27	1,600	44	55 (8.5)
Cu	150	110	135 (7.07)	240	220	35 (4.24)	-	190	42	43	180	57	153.3 (68.1)
Fe	3,200	3,600	5,700 (707.1)	5,700	3,700	20,500 (4,950)	-	25,000	26,000	18,000	35,000	28,000	20,333 (2,309)
Hg	0.86	-	0.65	0.84	0.80	0.02 (0.01)	-	0.14	0.06	-	0.19	0.34	0.09 (0.05)
Mn	-	-	860 (70.7)	530	-	-	-	980	880	-	-	810	-
Ni	10	6.5	10.8 (0)	14	11	18 (4.24)	-	22	26	19	810	24	27.7 (11.9)
Pb	150	97	150 (0)	110	100	22 (2.83)	-	630	19	30	160	100	387 (240)
Zn	240	220	270 (14.14)	310	370	79 (22.6)	-	600	98	70	1,100	860	720 (344)
Loss on Ignition	560	580	-	-	650	57 (14.14)	-	-	-	160	120	-	105 (32.8)
Solvent Extractables	-	-	-	22,000	-	-	-	-	1,300	-	-	2,900	-
Total Organic Carbon	-	260	215 (7.07)	250	270	21	-	97	44	-	58	60	53.3 (9.0)
Total PCBs	155	50	252.5 (17.88)	65	400	20 (0.0)	20.0	25	20	20	55	20	66.7 (37.9)
p,p-DDE	1.0	1.0	20 (1.41)	5.0	15	12 (15.56)	56.0	23	100	9.0	297	447	85.7 (119)
Hexachlorobenzene	3.0	3.0	2.5 (0.71)	1.0	8.0	1 (0.0)	4.0	1.0	28	7.0	40	25	1.0 (0.0)
Aldrin	13	1.0	1.0 (0.0)	1.0	1.0	17 (22.6)	1.0	1.0	1.0	1.0	1.0	1.0	1.0 (0.0)
alpha-BHC	1.0	1.0	1.0 (0.0)	1.0	1.0	1 (0.0)	1.0	1.0	1.0	1.0	1.0	1.0	1.0 (0.0)
beta-BHC	2.0	1.0	1.0 (0.0)	1.0	1.0	1 (0.0)	1.0	1.0	1.0	1.0	1.0	1.0	1.0 (0.0)
gamma-BHC	15	1.0	3.0 (2.8)	1.0	1.0	1 (0.0)	1.0	1.0	1.0	1.0	2.0	1.0	1.0 (0.0)
alpha-Chlordane	2.0	2.0	5.5 (3.5)	2.0	39	2 (0.0)	2.0	2.0	2.0	2.0	2.0	2.0	3.0 (1.7)
gamma-Chlordane	2.0	5.0	6.5 (3.5)	2.0	39	2 (0.0)	2.0	2.0	2.0	2.0	9.0	2.0	6.67 (5.51)
Dieldrin	14	9.0	6.5 (6.4)	2.0	2.0	7.5 (0.71)	9.0	57	2.0	2.0	109	2.0	36.7 (58.3)
Methoxychlor	7.0	16	5.0 (0.0)	5.0	5.0	6.5 (2.12)	5.0	5.0	5.0	5.0	95	5.0	56.7 (25.7)
Endrin	4.0	4.0	12.0 (11.3)	4.0	4.0	4 (0.0)	4.0	4.0	4.0	4.0	23	4.0	8.0 (1.0)
Endosulfan Sulphate	18	16	10.0 (7.07)	4.0	4.0	9.5 (7.78)	4.0	44	4.0	4.0	49	11	68 (53.7)
Endosulfan 1	12	2.0	20.5 (26.2)	2.0	2.0	2 (0.0)	31	30	2.0	2.0	24	2.0	13.3 (13.3)
Endosulfan 2	4.0	4.0	18.0 (17.0)	4.0	4.0	4 (0.0)	4.0	12	4.0	4.0	36	4.0	26 (19.1)
Heptachlor Epoxide	1.0	1.0	11.5 (14.8)	1.0	1.0	1 (0.0)	1.0	34	1.0	1.0	41	1.0	11 (9.54)
Heptachlor	1.0	1.0	1.0 (0.0)	1.0	1.0	1 (0.0)	1.0	1.0	1.0	1.0	1.0	1.0	1.0 (0.0)
Mirex	5.0	5.0	5.0 (0.0)	5.0	5.0	5 (0.0)	5.0	5.0	5.0	5.0	5.0	5.0	5.0 (0.0)
Octachlorostyrene	2.0	9.0	20.5 (26.2)	2.0	2.0	2 (0.0)	47	2.0	2.0	2.0	2.0	2.0	2.0 (0.0)

1 ug/g dry weight for metals and solvent extractables, ng/g for organic contaminants, and mg/g for LOI and TOC; concentrations below detection limits reported at detection limit.

2 Station 3 - Sewage Treatment Plant
Station 13 - Black Ash Creek
Station 14 - Oak Street Canal (storm drain)
Station 15 - Hickory Street Canal (storm drain)

* Two samples collected.

** Three samples collected.

\- No available data.

IC LOADINGS OF PHOSPHORUS AND SELECTED METALS FROM POINT SOURCES TO COLLINGWOOD HARBOUR (units are mg/sec)

	Total Phosphorus	Zn	Fe	Cu	Ni	Pb
Station 13 (Black Ash Creek)						
26.03.86	51	11	2,090	3.2	3.2	4.8
28.03.86	18	2.2	240	0.7	1.5	2.2
30.05.86	0.0002	0.0001	0.0007	0.000017	0.00003	0.0001
Station 14 (Oak Street Canal)						
27.03.86	3.7	3.4	6.3	0.11	0.56	1.1
30.05.86	0.0032	0.0011	0.0043	0.0001	0.0003	0.0005
Station 15 (Hickory Street Canal)						
26.03.86	0.78	0.67	14	0.10	0.016	0.31
29.03.86	0.33	0.38	3.8	0.045	0.010	0.13
30.05.86*	0.004	0.0006	0.005	0.0001	0.00003	0.0001
Station 3 (Sewage Treatment Plant)						
Annual Average, 1986	500**	19	9.5	0.73	0.99	1.8
Annual Average, 1987	160**	-	-	-	-	-

* Values calculated using streamflow on 30.05.86 and water chemistry from 28.05.86.

** Calculated from Table 2.1.

\- No available data.

APPENDIX II

CONTAMINANT CONCENTRATIONS IN RESIDENT BENTHIC INVERTEBRATES AND SCULPINS (1986)

ORGANIC COMPOUNDS IN BENTHIC INVERTEBRATES SAMPLED FROM COLLINGWOOD HARBOUR JULY 1986. VALUES ARE in UG/G (WET WEIGHT)

Station	Organism	9-NHC	a-Chlord	Dieldrin	Endrin	Hep.Epox.	Mirex	Tot PCB	pp-DDD
19	Oligochaete	0.004	0.010	ND	0.03	0.003	0.005	ND	ND
19	Chironomid	0.004	0.002	0.005	0.01	ND	0.003	ND	ND
20	Oligochaete	ND	0.006	ND	ND	ND	0.002	ND	0.029
20	Oligochaete	ND	0.003	ND	ND	ND	0.002	ND	0.015
21	Oligochaete	ND	0.009	ND	ND	ND	ND	ND	0.021
23	Oligochaete	ND	ND	ND	ND	ND	ND	ND	0.003
26	Oligochaete	ND	ND	ND	ND	ND	0.002	ND	0.018
28	Oligochaete	ND	ND	ND	ND	ND	ND	ND	ND
28	Chironomid	0.005	ND	ND	ND	ND	ND	ND	ND
30	Oligochaete	0.005	ND	ND	ND	ND	ND	ND	ND
32	Oligochaete	ND	ND	ND	ND	ND	ND	ND	ND
393	Chironomid	0.004	ND	ND	ND	ND	ND	ND	ND
Detection Limit		0.001	0.002	0.002	0.01	0.002	0.001	0.02	0.001

ND = Not Detectable

CONCENTRATIONS OF METALS IN BENTHIC INVERTEBRATES
SAMPLES COLLECTED INSIDE AND OUTSIDE COLLINGWOOD HARBOUR
IN JULY 1986
UNITS: ug/g (wet weight not corrected for gut content)

STATION	Biota	Cu	Cr	Hg	Cd	Fe	Pb	Zn	As	Mn	Al	Ni
0019	Chironomid	0.80	1.9	0.101	0.07	501	1.7	27	0.88	14.4	15	1.6
0020	Oligochaete	0.60	1.8	0.206	0.06	690	4.9	23	1.76	18.0	204	1.6
0021	Oligochaete	0.20	1.9	0.031	0.04	329	4.0	20	0.76	7.4	7	0.8
0023	Oligochaete	3.40	1.0	0.019	0.03	1180	9.6	23	0.32	19.2	260	1.8
0023	Oligochaete Dup	4.20	1.4	0.021	0.04	1460	6.6	26	0.39	24.2	300	1.8
0026	Oligochaete	0.90	2.2	0.101	0.07	914	4.9	22	1.02	28.8	242	2.8
0028	Oligochaete	0.30	2.9	0.060	0.08	717	2.7	21	1.60	21.9	10	1.3
0028	Chironomid	0.03	2.9	0.121	0.09	396	1.4	14	0.68	8.6	5	0.5
0030	Oligochaete	0.03	2.6	0.152	0.06	570	2.9	18	1.30	16.5	12	1.9
0032	Oligochaete	1.30	2.6	0.172	0.07	673	6.7	22	0.56	17.6	18	0.9
0032	Chironomid	0.70	5.3	0.139	0.03	280	2.4	14	0.05	3.8	9	0.1
0393	Chironomid	0.60	1.9	0.101	0.04	385	1.5	13	0.29	11.3	11	0.5
0395	Amphipods	3.60	8.4	0.218	0.24	159	2.0	17	0.75	6.4	172	0.2

CONCENTRATIONS OF METALS IN BOTTOM-FEEDING FISH (SCULPIN)
COLLECTED INSIDE AND OUTSIDE COLLINGWOOD HARBOUR IN JULY 1986
UNITS: ug/g (wet weight, not corrected for gut content)

STATION	BIOTA	AGE	As	Cu	Cr	Mn	Zn	Cd	Hg	Ni	Al	Fe	Pb
CR a	Bairdi	2-3 yrs	<0.02	1.7	0.4	6.1	36	0.09	0.086	3.1	16	38	0.2
CR Dup a	Bairdi	2-3 yrs	<0.02	1.3	0.3	4.2	27	0.05	0.066	1.0	14	24	0.2
CR b	Bairdi	4 yrs	0.02	2.2	0.6	2.8	25	0.27	0.051	3.9	49	28	0.4
CR Dup b	Bairdi	4 yrs	0.02	2.0	1.4	2.8	26	0.26	0.044	3.5	42	29	0.3
CR c	Bairdi	5 yrs	0.04	6.4	4.3	3.8	40	0.42	0.046	11.2	44	32	0.3
CR Dup c	Bairdi	5 yrs	0.02	3.5	4.0	2.5	33	0.30	0.046	6.8	46	28	<0.1
CR d	Bairdi	6-7 yrs	<0.02	1.7	0.4	3.4	31	0.28	0.069	2.3	46	10	0.1
CR Dup d	Bairdi	6-7 yrs	<0.02	2.6	0.2	2.0	30	0.25	0.072	3.7	25	9	<0.1
30A a	Bairdi	3-4 yrs	0.19	3.0	22.9	3.0	56	<0.02	<0.005	15.6	59	93	5.9
30A b	Bairdi	5 yrs	<0.02	1.9	1.3	2.9	27	0.15	0.040	5.8	139	22	0.4
30A Dup b	Bairdi	5 yrs	<0.02	2.3	0.9	3.3	29	0.11	0.044	5.2	152	23	0.2
30A c	Bairdi	6-8 yrs	<0.02	1.9	0.7	2.8	26	0.11	0.085	10.3	49	13	0.1
30A Dup c	Bairdi	6-8 yrs	<0.02	2.0	0.7	1.8	24	0.14	0.059	14.5	41	14	0.1
19 a	Bairdi	3-4 yrs	<0.02	2.2	0.5	3.5	24	0.15	0.042	8.1	29	29	0.2
19 Dup a	Bairdi	3-4 yrs	0.06	2.9	1.0	2.4	34	0.14	0.085	8.8	51	34	0.2
19 b	Bairdi	5 yrs	0.06	6.9	<0.1	3.7	32	<0.02	0.077	1.8	17	26	0.5
19 Dup b	Bairdi	5 yrs	0.04	3.9	<0.1	3.5	27	0.14	0.060	1.7	14	21	0.4
19 c	Bairdi	6-7 yrs	0.07	2.4	<0.1	2.5	49	0.27	0.045	3.4	15	19	0.5
19 Dup c	Bairdi	6-7 yrs	0.07	2.0	<0.1	2.3	43	0.30	0.042	2.4	9	18	0.3
NI a	Bairdi	2-3 yrs	<0.02	2.5	1.0	2.8	27	0.37	0.060	2.3	31	22	<0.1
NI Dup a	Bairdi	2-3 yrs	<0.02	1.6	1.5	2.9	24	0.37	0.041	8.0	44	26	<0.1
NI b	Bairdi	4 yrs	0.05	1.6	21.2	1.7	34	0.24	0.023	8.0	21	70	1.7
NI c	Bairdi	5 yrs	<0.02	1.2	0.7	2.2	26	0.23	0.066	2.6	16	13	<0.1
NI Dup c	Bairdi	5 yrs	<0.02	1.2	0.6	1.5	25	0.16	0.055	3.6	12	14	<0.1
NI d	Bairdi	6-7 yrs	0.04	1.1	15.1	1.7	40	0.15	0.042	5.2	1	40	1.3
395 a	Bairdi	3 yrs	0.05	3.9	0.9	3.9	39	0.24	0.058	5.5	63	36	<0.1
395 Dup a	Bairdi	3 yrs	0.06	4.1	0.4	3.5	21	0.23	0.061	5.3	95	48	<0.1
395 b	Bairdi	4 yrs	<0.02	2.1	2.0	2.4	23	0.32	0.074	4.6	19	24	0.2
395 Dup b	Bairdi	4 yrs	<0.02	2.2	2.8	2.4	25	0.27	0.043	3.6	63	21	0.1
395 c	Bairdi	5 yrs	<0.02	5.0	40.5	1.8	33	0.14	0.028	13.4	23	65	1.3
395 Dup c	Bairdi	5 yrs	0.07	1.4	29.9	2.9	45	0.24	0.053	10.7	9	76	1.7

Key: < = Less Than Detection Limit
- = No Data

CONCENTRATIONS OF ORGANIC COMPOUNDS IN BOTTOM-FEEDING FISH (SCULPINS)
UNITS: ug/g (wet weight, not corrected for gut content)

STATION	Biota	Age	Tot.PCB	a-BHC	HCB	a-Chlord	pp-DDE	pp-DDD	pp-DDT
CR Dup a	Bairdi	2-3 yrs	-	-	-	-	-	-	-
CR b	Bairdi	4 yrs	<0.02	<0.001	0.002	<0.002	0.008	0.013	<0.005
CR Dup b	Bairdi	4 yrs	<0.02	0.002	0.002	0.002	0.011	0.011	<0.005
CR c	Bairdi	5 yrs	<0.02	0.002	<0.001	<0.002	0.004	<0.001	0.006
CR Dup c	Bairdi	5 yrs	<0.02	0.002	<0.001	0.004	0.009	<0.001	0.008
CR d	Bairdi	6-7 yrs	0.04	0.003	0.003	0.003	0.012	0.015	0.008
CR Dup d	Bairdi	6-7 yrs	0.03	0.002	0.002	<0.002	0.010	0.016	0.007
30A a	Bairdi	3-4 yrs	-	-	-	-	-	-	-
30A b	Bairdi	5 yrs	0.07	0.002	0.003	0.005	0.020	0.015	0.014
30A Dup b	Bairdi	5 yrs	0.07	0.003	0.003	<0.002	0.021	0.016	0.005
30A c	Bairdi	6-8 yrs	0.07	0.002	0.002	<0.002	0.019	0.009	<0.005
30A Dup c	Bairdi	6-8 yrs	0.09	0.003	0.003	0.008	0.018	0.016	<0.005
19 a	Bairdi	3-4 yrs	<0.02	0.003	0.004	0.012	0.030	0.019	0.009
19 Dup a	Bairdi	3-4 yrs	<0.02	0.004	0.003	0.009	0.028	0.018	<0.005
19 b	Bairdi	5 yrs	<0.02	<0.001	0.001	<0.002	0.005	<0.001	<0.005
19 Dup b	Bairdi	5 yrs	<0.02	<0.001	0.002	<0.002	0.013	0.004	<0.005
19 c	Bairdi	6-7 yrs	<0.02	<0.001	0.003	0.003	0.004	<0.001	<0.005
19 Dup c	Bairdi	6-7 yrs	<0.02	<0.001	0.007	<0.002	0.003	<0.001	<0.005
NI a	Bairdi	2-3 yrs	<0.02	<0.001	<0.001	0.008	0.037	0.009	0.039
NI Dup a	Bairdi	2-3 yrs	<0.02	0.004	0.002	0.009	0.003	0.011	0.027
NI b	Bairdi	4 yrs	0.11	<0.001	0.005	0.004	0.006	<0.001	<0.005
NI Dup b	Bairdi	4 yrs	0.10	<0.001	0.005	0.004	0.011	<0.001	<0.005
NI c	Bairdi	5 yrs	0.03	<0.001	0.001	0.004	0.011	<0.001	<0.005
NI Dup c	Bairdi	5 yrs	0.02	<0.001	0.001	<0.002	0.008	<0.001	<0.005
NI d	Bairdi	6-7 yrs	0.03	<0.001	0.002	0.003	0.008	<0.001	<0.005
NI Dup d	Bairdi	6-7 yrs	0.05	<0.001	0.003	<0.002	0.005	<0.001	<0.005

Key: < = less than Detection Limit
- = No Data

CONCENTRATIONS OF ORGANIC COMPOUNDS IN BOTTOM-FEEDING FISH (SCULPINS)
UNITS: ug/g (wet weight, not corrected for gut content)

STATION	Biota	Age	Tot.PCB	a-BHC	HCB	a-Chlord	pp-DDE	pp-DDD	pp-DDT
395 a	Bairdi	3 yrs	0.03	0.003	0.001	0.003	0.013	0.014	0.008
395 Dup a	Bairdi	3 yrs	0.02	0.002	0.001	0.003	0.012	0.011	0.007
395 b	Bairdi	4 yrs	<0.02	<0.001	0.001	<0.002	<0.001	<0.001	<0.005
395 Dup b	Bairdi	4 yrs	<0.02	<0.001	0.001	<0.002	0.002	<0.001	<0.005
395 c	Bairdi	5 yrs	0.07	<0.001	0.003	<0.002	<0.001	<0.001	<0.005
395 Dup c	Bairdi	5 yrs	0.10	<0.001	0.003	<0.002	<0.001	<0.001	<0.005
395 d	Bairdi		<0.02	0.002	<0.001	0.004	0.008	0.005	0.012
395 Dup d	Bairdi		<0.02	0.002	<0.001	0.004	0.006	0.012	0.022
393 a	Bairdi	3-4 yrs	<0.02	0.004	<0.001	0.008	0.028	0.015	0.035
393 Dup a	Bairdi	3-4 yrs	<0.02	0.003	<0.001	0.002	0.006	0.012	0.014
393 b	Bairdi	5 yrs	0.08	0.002	<0.001	<0.002	<0.001	<0.001	<0.005
393 Dup b	Bairdi	5 yrs	0.02	0.005	0.002	0.006	0.027	0.020	0.009
393 c	Bairdi	7 yrs	<0.02	0.002	<0.001	<0.002	<0.001	0.012	0.009
393 d	Bairdi	8 yrs	0.04	<0.001	0.004	0.003	0.004	<0.001	<0.005
393 Dup d	Bairdi	8 yrs	<0.02	<0.001	0.004	<0.002	0.004	<0.001	<0.005
BPR a	Bairdi	3 yrs	<0.02	<0.001	0.002	0.004	0.017	0.002	<0.005
BPR b	Bairdi	4 yrs	0.05	<0.001	<0.001	0.005	0.012	0.002	<0.005
BPR c	Bairdi	5 yrs	0.04	<0.001	0.010	0.004	0.012	<0.001	<0.005
BPR d	Bairdi	6-7 yrs	<0.02	<0.001	0.002	<0.002	0.003	<0.001	<0.005
BPR Dup d	Bairdi	6-7 yrs	0.05	<0.001	<0.001	0.003	0.002	<0.001	<0.005
BPR e	Bairdi	8 yrs	0.05	<0.001	<0.001	<0.002	<0.001	<0.001	<0.005
BPR Dup e	Bairdi	8 yrs	<0.02	<0.001	<0.001	<0.002	<0.001	<0.001	<0.005
387 a	Bairdi	3 yrs	<0.02	<0.001	0.009	<0.002	0.008	<0.001	<0.005
387 b	Bairdi	4 yrs	0.03	<0.001	0.003	<0.002	0.003	<0.001	<0.005
387 Dup b	Bairdi	4 yrs	0.02	<0.001	0.006	<0.002	0.003	0.003	<0.005
387 c	Bairdi	5 yrs	0.02	<0.001	0.004	<0.002	0.003	<0.001	<0.005
387 Dup c	Bairdi	5 yrs	0.04	<0.001	0.002	0.002	0.006	<0.001	<0.005
387 d	Bairdi	7 yrs	<0.02	<0.001	<0.001	0.005	0.010	<0.001	0.012
387 Dup c	Bairdi	7 yrs	0.03	<0.001	<0.001	<0.002	<0.001	<0.001	<0.005
394 a	Bairdi	3 yrs	<0.02	0.005	<0.001	0.006	0.019	0.024	0.021
394 Dup a	Bairdi	3 yrs	0.02	0.004	<0.001	0.007	0.024	0.016	0.019
394 b	Bairdi	4 yrs	-	-	-	-	-	-	-
394 c	Bairdi	5 yrs	0.02	<0.001	<0.001	<0.002	<0.001	<0.001	<0.005

Remedial Action Plan
Plan d'Assainissement

Canada Ontario

Canada-Ontario Agreement Respecting Great Lakes Water Quality
L'Accord Canada-Ontario relatif à la qualité de l'eau dans les Grand Lacs